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1995
AMENDMENTS
to the
Program of Studies: Senior High Schools

1. Replace front-end pages i to xiii with new pages i to xi.
2. BUSINESS EDUCATION: Replace Business Education title page (following Business Education divider).
3. HOME ECONOMICS: Replace Home Economics title page (following Home Economics divider).
4. INDUSTRIAL EDUCATION: Replace Industrial Education title page (following Industrial Education divider).
5. LANGUAGE ARTS:
   - Replace Language Arts title page (following Language Arts divider).
   - Replace English Language Arts, pages 35 to 42.
6. MATHEMATICS:
   - Replace Mathematics 31, pages 1 to 7, with Mathematics 31, pages 1 to 53.
   - Replace Mathematics 13–23–33, page 25.
7. NATIVE LANGUAGES: Replace Native Languages title page (following Native Languages divider).
8. OTHER COURSES:
   - Replace Other Courses title page (following Other Courses divider).
   - Replace Special Projects 10–20–30, pages 1 and 2.
   - Replace Work Experience 15–25–35, page 1.
9. PERSONAL DEVELOPMENT:
   - Replace Personal Development title page (following Personal Development divider).
   - Replace Physical Education 10–20–30, pages 3 to 6.
10. SCIENCE:
    - Replace Science title page (following Science divider).
    - Remove Science [general introduction, revised 1984] pages 1 to 4.
    - Replace old [revised 1984] Biology 10–20–30 pages 1 to 13 with new [revised 1995] Biology 20–30, page 1.
    - Replace old [revised 1984] Chemistry 10–20–30 pages 1 to 9 with new [revised 1995] Chemistry 20–30, page 1.
    - Replace old [revised 1984] Physics 10–20–30, 22–32 pages 1 to 7 with new [revised 1995] Physics 20–30, page 1.
    - Insert new Science 20–30, page 1 <u>after</u> Physics 20–30 and <u>before</u> Science 14–24.
11. SECOND LANGUAGES:
    - Replace Second Languages title page (following Second Languages divider).
    - Replace French as a Second Language, pages 19 and 20.

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1995
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PROGRAM of STUDIES

Senior High Schools

This Program of Studies is issued under the authority of the Minister of Education pursuant to section 25(1) of the *School Act*, Statutes of Alberta, 1988, Chapter S–3.1 as amended.

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Alberta
EDUCATION

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This document reflects changes in the program of studies for senior high schools up to June 1995.

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PROGRAM OF STUDIES: SENIOR HIGH SCHOOLS

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Course	A. Program Rationale and Philosophy	B. General Learner Expectations	C. Curriculum Standards/ Specific Learner Expectations	D. Basic Learning Resources
Business Education [general]	1985	1985		
Accounting 10–20–30		1985	1985	1989
Basic Business 20–30		1985	1985	1989
Computer Processing 10–20–30		1985	1985	1989
Law 20–30		1985	1985	1989
Marketing 20–30		1985	1985	1985
Office Procedures 20–30		1985	1985	1989
Shorthand 20–30		1985	1985	1989
Typewriting 10–20–30		1985	1985	1989
Business Education 10–20–30		1985	1985	1989
Computer Literacy 10	1984	1984	1984	1984
★★Career and Technology Studies				
Fine Arts				
Art [general]	1986	1986		
Art 10–20–20			1986	1986
Art 11–21–31	1986	1986	1986	1986
Drama 10–20–30	1989	1989	1989	1989
Choral Music 10–20–30	1991	1991	1991	1991
General Music 10–20–30	1994	1994	1994	1994
Instrumental Music 10–20–30	1991	1991	1991	1991
Home Economics [general]	1983	1983		
Clothing and Textiles 10–20–30	1983	1983	1983	1983
Food Studies 10–20–30	1983	1983	1983	1983
Personal Living Skills 10–20–30	1983	1983	1983	1983

The dates in the grid indicate the most current and up-to-date sections in each program of studies.

★★ Business Education, Home Economics and Industrial Education courses will be replaced by the provincial implementation of Career and Technology Studies (CTS) strands in the 1997–98 school year.

Course	A. Program Rationale and Philosophy	B. General Learner Expectations	C. Curriculum Standards/ Specific Learner Expectations	D. Basic Learning Resources
Industrial Education [general]	1983	1983		
Industrial Education 10–20–30 Series				
General Courses				
Drafting 10–20		1978	1978	1978
Industrial Education 10–20–30			1983	
Electricity–Electronics		1983	1983	1983
Materials		1983	1983	1983
Power Technology		1983	1983	1983
Visual Communications		1983	1983	1983
Agriculture 10–20–30	1990★			
Production Science 30	1978	1978	1978	1978
Industrial Education 12–22–32 Series [general]	1983			
Career Fields				
Construction and Fabrication				
Building Construction 12–22–32 Series		1983	1983	1983
Machine Shop 12–22–32 Series		1983	1983	1983
Piping 12–22–32 Series		1983	1983	1983
Sheet Metal 12–22–32 Series		1983	1983	1983
Welding 12–22–32 Series		1983	1983	1983
Electricity–Electronics				
Electricity–Electronics 12		1983	1983	1983
Electricity 22–32 Series		1983	1983	1983
Electronics 22–32 Series		1983	1983	1983
Graphic Communications				
Drafting 12–22–32 Series		1983	1983	1983
Visual Communications 12–22–32 Series		1983	1983	1983
Graphic Arts 22–32 Series		1983	1983	1983
Horticulture				
Horticulture 12–22–32 Series		1983	1983	1983
Mechanics				
Mechanics 12		1983	1983	1983
Related Mechanics 22–32 Series		1983	1983	1983
Automotives 22–32 Series		1983	1983	1983
Auto Body 12–22–32 Series		1983	1983	1983
Personal Services				
Beauty Culture 12–22–32 Series		1983	1983	1983
Food Preparation 12–22–32 Series		1983	1983	1983
Health Services 12–22–32 Series		1983	1983	1983

★ Program information only.

Course	A. Program Rationale and Philosophy	B. General Learner Expectations	C. Curriculum Standards/ Specific Learner Expectations	D. Basic Learning Resources
Integrated Occupational Program				
English 16–26–36	1992	1992	1992	1992
Occupational Component 16–26–36	1992	1992	1992	1992
Social Studies 16–26	1992	1992	1992	1992
Language Arts				
English Language Arts	1981	1981		
English 10–20–30			1981	1995
English 13–23–33			1981	1995
Communications 21a–21b			1978	
Literature 21a–21b			1978	
Reading 10	1987	1987	1987	1987
English as a Second Language 10a–10b–10c	1986★			
Français 10–20–30	1994★			
French Language Arts 10–20–30	1994★			
Ukrainian Language Arts	1990	1990	1990	1994
Mathematics				
Mathematics 10–20–30	1991	1991	1991	1994
Mathematics 31	1995	1995	1995	1995
Mathematics 13–23–33	1991	1991	1991	1995
Mathematics 14–24	1990	1990	1990	1990
Native Languages				
Blackfoot Language and Culture 10–20–30	1993	1993	1993	1993
Cree Language and Culture 10–20–30	1993	1993	1993	1993
Other Courses				
Special Projects 10–20–30	1995			
Work Experience 15–25–35	1995			
Personal Development				
Health and Personal Development 10	1985	1985	1985	1985
Career and Life Management 20	1989	1989	1989	1989
Occupations 10		1978	1978	1978
Physical Education 10–20–30	1988	1988	1988 pp. 4–5, 1995	1988
Driver and Traffic Safety Education 10	1983	1983	1983	1983
Science				
Science (Vision Statement)	1994			
Science 10	1992	1992	1992	1992
Biology 20–30 Chemistry 20–30 Physics 20–30 Science 20–30	Provincial Implementation • 20-level—1993 • 30-level—1994 Copies of the interim programs of study, dated June 30, 1995, are available for purchase from the Learning Resources Distributing Centre.			
Science 14–24	1994	1989	1989 pp. 7–8, 1994	1989

★Program information only.

Course	A. Program Rationale and Philosophy	B. General Learner Expectations	C. Curriculum Standards/ Specific Learner Expectations	D. Basic Learning Resources
Second Languages				
French as a Second Language	1992	1992 pp 7–8, 1994	1992 pp. 12–14, 1994 pp 17–18, 1994	1995
German	1984	1984	1984	1993
Italian	1986	1986	1986	1994
Latin	1986	1986	1986	1986
Spanish	1983	1983	1983	1983
Ukrainian	1983	1983	1983	1983
Social Sciences [general]	1985	1985		
Anthropology				
Cultural and Physical Anthropology 30		1985	1985	1985
Economics		1985		
Economics for Consumers 20			1985	1985
Microeconomics 30			1985	1985
Macroeconomics 30			1985	1985
Geography		1985	1985	
Local and Canadian Geography 20			1985	1985
World Geography 30			1985	1985
History				
Western Canadian History 20		1985	1985	1985
Canadian History 20		1985	1985	1985
Western World History 30		1985	1985	1985
Philosophy				
Origins of Western Philosophy 20		1985	1985	1985
Contemporary Western Philosophy 20		1985	1985	1985
Philosophies of Man 30		1985	1985	1985
Political Science				
Political Thinking 20		1985	1985	1985
Comparative Government 20		1985	1985	1985
International Politics 30		1985	1985	1985
Psychology		1985		
Personal Psychology 20			1985	1985
General Psychology 20			1985	1985
Experimental Psychology 30			1985	1985
Religious Studies		1985		
Religious Ethics 20			1985	1985
Religious Meanings 20			1985	1985
World Religions 30			1985	1985
Sociology		1985		
General Sociology 20			1985	1990
Sociological Institutions 20			1985	1990
Applied Sociology 30			1985	1990
Social Studies				
Social Studies 10–20–30	1990	1990	1990 pp 41–60, 1993	1994
Social Studies 13–23–33	1990	1990	1990 pp 39–54, 1993	1994

INTRODUCTION

The *Program of Studies: Senior High Schools* identifies the learning expectations for all students. Content is focused on what students are expected to know and be able to do.

Though the program is organized into separate subject or course areas, there are many connections across the curriculum. Students see the world as a connected whole rather than as isolated bits. Integrating across content areas, and providing ways for students to make connections, enhances student learning. The reporting of student progress and certification of student learning should, nevertheless, be in terms of the expectations outlined in each course of studies.

Within any group of students there is a range of individual differences. Flexibility in planning for individuals within a group is needed. Therefore, school organization and teacher methodology are not mandated at the provincial level and may vary from class to class and school to school in order to meet student needs.

For guidelines and regulations relating to school programs and operations refer to the current issue of the *Guide to Education: Senior High School Handbook*. Alberta Education also produces a variety of publications to support the programs of study, all of which are available for purchase from the Learning Resources Distributing Centre. Basic and support student learning resources, and authorized teaching resources, are listed in the Learning Resources Distributing Centre *Buyers Guide.*

PROGRAM FOUNDATIONS: MISSION AND MANDATE★

Mission

"The best possible education for all Alberta students."

Mandate

Education is responsible for ensuring that students have the opportunity to acquire the knowledge, skills and attitudes needed to be self-reliant, responsible, caring and contributing members of society.

Beliefs

We believe:

- All students can learn and experience success
- All students have the right of equitable access to a quality basic education program that meets their diverse needs
- Students are responsible for participating fully in the achievement of their educational success
- All students must have strong reading, writing and math skills with which to analyze data and develop ideas and inferences
- Students are entitled to a safe, secure and caring learning environment where each individual is respected and valued
- Education is an essential building block of our society's future
- The education system must provide our society with creative and critical thinkers and problem solvers, who are prepared for the world of work, post-secondary studies, lifelong learning and citizenship in a complex world
- The education system must provide opportunities for students to acquire the entrepreneurial and technical skills and work habits required for success in the rapidly changing, high-tech global economy
- Quality educational programs develop the total person—social, physical, intellectual, cultural and emotional dimensions
- High learning expectations challenge all students to learn and achieve
- The success of students is the shared responsibility of students, parents, school, community and government
- Parents should have opportunities for meaningful involvement in important decisions about their children's education
- Parents and the public should have access to timely information about the performance and cost of the education system
- The satisfaction of students, parents and the public is critical to the success of the education system
- Resources and relevant decision making should be located where education happens
- All those responsible for decisions about education, including the expenditure of education funds, are accountable to Albertans for actions and results
- Available resources can maintain and improve the quality of education for students, if managed efficiently and innovatively
- The provision of educational funding must be fair, adequate and affordable.

★ This Mission and Mandate has been excerpted from pages 7–10 of *Meeting the Challenge II. Three-Year Business Plan for Education*, 1995/96–1997/98 and replaces Goals of Education, Goals of Schooling and Desirable Personal Characteristics in previous programs of study

Basic Education—the Definition

The school's first obligation is to provide a solid core program consisting of language arts, mathematics, science and social studies.

Schools have the responsibility to provide instructional programs that ensure students will meet the provincial graduation requirements and are prepared for entry into the workplace or post-secondary studies. As well, schools must ensure that students understand the rights and responsibilities of citizenship, and have the skills and disposition to pursue learning throughout their lives.

Learning Expectations

Schools will be accountable for their students' achievement of provincial learning standards including employability skills consistent with workplace requirements.

Schools will provide a variety of learning experiences so that students:

- can read for information, understanding and enjoyment
- write and speak clearly, accurately and appropriately for the context
- use mathematics to solve problems in business, science and daily-life situations
- understand the physical world, ecology and the diversity of life
- understand the scientific method and the societal context of science
- know the history and geography of Canada and have a general understanding of world history and geography
- understand Canada's political, social and economic systems within a global context
- can research an issue thoroughly
- know how to work independently and as part of a team
- respect the cultural diversity of Canada, and appreciate literature and the arts
- know the basic requirements of an active, healthful lifestyle
- recognize the importance of accepting responsibility for their physical and emotional well-being, and appreciate the role of the family and other relationships to that well-being
- manage time and other resources needed to complete a task
- use computer and communication technologies
- demonstrate initiative, leadership, flexibility and persistence
- evaluate their own endeavours and continually strive to improve
- have the desire and realize the need for lifelong learning.

Schools also may provide the opportunity for students to acquire a second language. When the primary language of instruction is not English, students must be able to demonstrate competence in reading and writing English.

Education Delivery

Schools must engage students in a variety of activities that enable them to acquire the expected learnings.

The expected learnings can be achieved in many ways: many students will require concrete, hands-on approaches to achieve the expected results. Schools will have authority to deploy resources and may use any instructional technique acceptable to the community as long as the results are achieved. Schools and teachers are encouraged to take advantage of different delivery options, such as distance education and workplace learning.

Senior high school students will be able to learn employability skills in the workplace. The school will provide support to ensure a broad theoretical understanding of those specific skills. The province will provide high school credit for workplace learning that is certified by the school and by the employer. This will ensure that students have the skills demanded by business and

gain recognized work experience to assist in making the transition from school to work.

Wherever possible, school programs and credit granting procedures will be redesigned to ensure compatibility with post-secondary and occupational training programs, thus improving the efficiency of the entire system by removing duplication.

Achievement Standards

Individual school results will vary but our total provincial system must be accountable for ensuring that a very high proportion of students are successful.

The province will define acceptable standards and standards of excellence for student achievement. Business will be a key player in defining the specific learning requirements of industry. Schools, school jurisdictions and the province will assess and report on the full range of student learning.

The school's primary responsibility is to ensure that students meet or exceed the provincial standards, as reflected in student learning expectations, provincial achievement tests, diploma exams and graduation requirements. Schools will consult with parents and other members of their communities about student performance, and set specific improvement targets.

RELIGIOUS AND PATRIOTIC INSTRUCTION

There is one section in the *School Act* which has to do with religious and patriotic instruction. It is reproduced here for the information of teachers and administrators.

SECTION 33(1) A board may

(a) prescribe religious instruction to be offered to its students;

(b) prescribe religious exercises for its students;

(c) prescribe patriotic instruction to be offered to its students;

(d) prescribe patriotic exercises for its students;

(e) permit persons other than teachers to provide religious instruction to its students.

(2) Where a teacher or other person providing religious or patriotic instruction receives a written request signed by a parent of a student that the student be excluded from religious or patriotic instruction or exercises, or both, the teacher or other person shall permit the student

(a) to leave the classroom or place where the instruction or exercises are taking place for the duration of the instruction or exercises, or

(b) to remain in the classroom or place without taking part in the instruction or exercises.

1988 cS–3.1 s33; 1990 c36 s16

LEARNING RESOURCES

POLICY

Alberta Education selects, acquires, develops, produces, translates and authorizes the best possible instructional materials for the implementation of approved programs of study.

LEARNING RESOURCE CATEGORIES

In terms of provincial policy, learning resources are those print, nonprint and electronic software materials used by teachers or students to facilitate teaching and learning. Many learning resources, both publisher developed and teacher made, are available for use in implementing senior high school programs. Decisions about the selection and use of resources are a local matter and should take into account the student skill levels, interests, motivations and stages of development.

Alberta Education authorizes learning resources in three categories:

- basic student learning resources
- support student learning resources
- authorized teaching resources.

Authorization indicates that the resources meet high standards and can contribute to the attainment of the goals of the program. However, the authorization of resources does not require their use in program delivery.

Basic Student Learning Resources

Basic learning resources are those student learning resources authorized by Alberta Education as the most appropriate for addressing the majority of learner expectations of the course(s), substantial components of the course(s), or the most appropriate for meeting general learner expectations across two or more grade levels, subject areas or programs as outlined in provincial programs of study. These may include any resource format, such as print, computer software, manipulatives or video.

In exceptional circumstances, a teacher resource may be given basic status.

Support Student Learning Resources

Support learning resources are those student learning resources authorized by Alberta Education to assist in addressing some of the learner expectations of course(s) or components of course(s); or to assist in meeting the learner expectations across two or more grade levels, subject areas or programs as outlined in the provincial programs of study. These may include any resource format, such as print, computer software, manipulatives or video.

Authorized Teaching Resources

Authorized teaching resources are those teaching resources produced externally to Alberta Education (for example, by publishers) that have been reviewed by Alberta Education, found to meet the criteria of review and to be the best available resources to support the implementation of programs of study and courses, and the attainment of the goals of education; they have been authorized by the Minister. Teaching resources produced as service documents by Alberta Education, such as teacher resource manuals (TRMs), diagnostic programs and monographs, are authorized by definition.

AVAILABILITY

Most authorized resources are available for purchase from the Learning Resources Distributing Centre, 12360 – 142 Street, Edmonton, Alberta, T5L 4X9 (Telephone 427–2767, Fax 422–9750).

Resources are listed in the Learning Resources Distributing Centre *Buyers Guide*.

BUSINESS EDUCATION

CONTENTS

Business Education [general]

Accounting 10–20–30

Basic Business 20–30

Computer Processing 10–20–30

Law 20–30

Marketing 20–30

Office Procedures 20–30

Shorthand 20–30

Typewriting 10–20–30

Business Education 10–20–30

Computer Literacy 10

CAREER AND TECHNOLOGY STUDIES (CTS)

Senior High School Implementation

Business Education, Home Economics and Industrial Education courses will be replaced by the provincial implementation of Career and Technology Studies (CTS) strands in the 1997–98 school year. However, the following strands are currently available for optional implementation.

Agriculture
Career Transitions
Communication Technology
Construction Technology
Cosmetology
Design Studies
Energy and Mines
Enterprise and Innovation
Fabrication Studies
Fashion Studies
Financial Management
Foods
Forestry
Information Processing
Legal Studies
Management and Marketing
Mechanics
Tourism Studies
Wildlife

Each strand has a *Guide to Standards and Implementation* containing the philosophy, rationale, learner expectations, organization, module curriculum and assessment standards and tools, learning resources guide and sample student learning guides. Documents are available for purchase from the Learning Resources Distributing Centre (LRDC).

Basic, support and authorized teaching resources information for the present practical arts programs, and the CTS strands, is in the LRDC *Buyers Guide*.

For further information about CTS strands, contact the Curriculum Standards Branch, Alberta Education. Telephone 403–422–4872. Fax 403–422–0576. Mailing address: Devonian Building, West Tower, 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2.

HOME ECONOMICS

CONTENTS

Home Economics [general]

Clothing and Textiles 10–20–30

Food Studies 10–20–30

Personal Living Skills 10–20–30

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Construction Technology
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INDUSTRIAL EDUCATION

CONTENTS

INDUSTRIAL EDUCATION [general]

INDUSTRIAL EDUCATION 10–20–30 SERIES GENERAL COURSES

Drafting 10–20
Industrial Education 10–20–30
Agriculture 10–20–30
Production Science 30

INDUSTRIAL EDUCATION 12–22–32 SERIES CAREER FIELDS

Construction and Fabrication

Building Construction 12
Building Construction 22a
Building Construction 22b
Building Construction 22c
Building Construction 32a
Building Construction 32b
Building Construction 32c
Machine Shop 12
Machine Shop 22a
Machine Shop 22b
Machine Shop 22c
Machine Shop 32a
Machine Shop 32b
Machine Shop 32c
Piping 12
Piping 22a
Piping 22b
Piping 22c
Piping 32a
Piping 32b
Piping 32c
Sheet Metal 12
Sheet Metal 22a
Sheet Metal 22b
Sheet Metal 22c
Sheet Metal 32a
Sheet Metal 32b
Sheet Metal 32c

CAREER AND TECHNOLOGY STUDIES (CTS)

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Cosmetology
Design Studies
Energy and Mines
Enterprise and Innovation
Fabrication Studies
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Legal Studies
Management and Marketing
Mechanics
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Welding 12
Welding 22a
Welding 22b
Welding 22c
Welding 32a
Welding 32b
Welding 32c

Electricity-Electronics

Electricity-Electronics 12
Electricity 22a
Electricity 22b
Electricity 22c
Electricity 32a
Electricity 32b
Electricity 32c
Electronics 22a
Electronics 22b
Electronics 22c
Electronics 32a
Electronics 32b
Electronics 32c

Graphic Communications

Drafting 12
Drafting 22a
Drafting 22b
Drafting 22c
Drafting 32a
Drafting 32b
Drafting 32c
Visual Communications 12
Visual Communications 22a
Visual Communications 22b
Visual Communications 22c
Visual Communications 32a
Visual Communications 32b
Visual Communications 32c
Graphic Arts 22a
Graphic Arts 22b
Graphic Arts 22c
Graphic Arts 32a
Graphic Arts 32b
Graphic Arts 32c

Horticulture

Horticulture 12
Horticulture 22a
Horticulture 22b
Horticulture 22c
Horticulture 32a
Horticulture 32b
Horticulture 32c

Mechanics

Mechanics 12
Related Mechanics 22a
Related Mechanics 22b
Related Mechanics 22c
Related Mechanics 32a
Related Mechanics 32b
Related Mechanics 32c
Automotives 22a
Automotives 22b
Automotives 22c
Automotives 32a
Automotives 32b
Automotives 32c
Auto Body 12
Auto Body 22a
Auto Body 22b
Auto Body 22c
Auto Body 32a
Auto Body 32b
Auto Body 32c

Personal Services

Beauty Culture 12
Beauty Culture 22a
Beauty Culture 22b
Beauty Culture 22c
Beauty Culture 32a
Beauty Culture 32b
Beauty Culture 32c
Beauty Culture 32d
Food Preparation 12
Food Preparation 22a
Food Preparation 22b
Food Preparation 22c
Food Preparation 32a
Food Preparation 32b
Food Preparation 32c
Food Preparation 32d
Health Services 12
Health Services 22
Health Services 32a
Health Services 32b

LANGUAGE ARTS

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★ For current information on basic learning resources, consult the Learning Resources Distributing Centre *Buyers Guide*.

D. BASIC LEARNING RESOURCES

ENGLISH 10

Print

Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt, 1991. [composition and language]

ISBN 0774731443

Cameron, B. *On Stage 1.* Globe Modern, 1984. [modern drama]

ISBN 0889960941

_____. *Poetry in Focus.* Globe Modern, 1983. [poetry]

ISBN 0889960666

Davies, R. and G. Kirkland. *Dimensions: A Book of Essays.* Gage, 1986. [nonfiction]

ISBN 0771568541

_____. *Inside Stories I.* HBJ-Holt, 1987. [short stories]

ISBN 0774712716

Gill, R. (ed.) *Julius Caesar.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319711

_____. *The Merchant of Venice.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319738

_____. *A Midsummer Night's Dream.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319754

_____. *Romeo and Juliet.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 019831972X

Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

ISBN 017603515X

Jewkes, W. T. *Man the Myth-Maker.* Second edition. HBJ-Holt-Saunders, 1981. [multigenre]

ISBN 0153334681

Law, H. (ed.) *A Midsummer Night's Dream.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712678

Lottridge, C. et al. *Mythic Voices: Reflections in Mythology.* Nelson Canada, 1991. [multigenre]

ISBN 0176037136

Lunsford, A. et al. *The St. Martin's Handbook for Canadians.* Nelson Canada, 1991. [handbook]

ISBN 0176034935

MacNeill, J. A. *Sunburst.* Nelson Canada, 1982. [poetry]

ISBN 017601814X

MacNeill, J. A. et al. *Sunlight and Shadows.* Nelson Canada, 1974. [short stories]

ISBN 0176329196

Maitman, M. and I. Waldron (eds.). *The Merchant of Venice.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712635

Patenaude, A. (ed.) *Julius Caesar.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712619

Paustian, S. I. *Through the Open Window.* Oxford University Press, 1983. [poetry]

ISBN 0195404122

Roy, K. (ed.) *Romeo and Juliet.* HBJ-Holt, 1987. [Shakespeare]

ISBN 0774712694

Schoen, C. *The Writing Experience.* Canadian edition. McClelland & Stewart, 1981. [composition and language]

ISBN 0771080026

Nonprint

Claris. *AppleWorks.* Version 3.0, 1989.
[computer courseware]
IBM Version 2.0, 1992

Microsoft Canada. *Microsoft Word.*
[computer courseware]
IBM Version 5.5, 1990
IBM Version 6.0, 1993
Macintosh Version 4.0, 1989

Microsoft Canada Inc. *Microsoft Word for Windows.*
[computer courseware]
IBM Version 2.0, 1992

Microsoft Corporation. *Microsoft Works.*
[computer courseware]
IBM Version 2.0, 1989
Macintosh Version 2.0a, 1989

WordPerfect Corporation. *WordPerfect.*
[computer courseware]
Apple IIGS Version 2.1, 1990
IBM Version 5.1, 1990
Macintosh Version 2.0, 1990

ENGLISH 20

Print

Barry, J. *Themes on the Journey: Reflections in Poetry.* Nelson Canada, 1989. [poetry]

ISBN 0176030891

Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt Canada, 1991. [composition and language]

ISBN 0774731443

Cameron, B. *On Stage 2.* Globe Modern, 1984. [modern drama]

ISBN 0889960968

Davies, R. and G. Kirkland. *Inside Stories II.* HBJ-Holt, 1987. [short stories]

ISBN 0774712724

Eaton, D. F. *On Cue 2.* HBJ-Holt, 1991. [modern drama]

ISBN 0774713690

Gehle, Q. L. and D. J. Rollo. *The Writing Process.* Canadian edition. Nelson Canada, 1981. [composition and language]

ISBN 0176015310

Gill, R. (ed.) *Macbeth.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319703

Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

ISBN 017603515X

Hilker, Douglas. *Inside Essays II.* Harcourt Brace Jovanovich, Canada, 1993. [nonfiction]

ISBN 0774714026

Kellow, B. and J. Krisak. *Essays: Thought and Style.* Prentice Hall, 1987. [nonfiction]

ISBN 0132835738

Kortes, M. (ed.) *Macbeth.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712708

Lunsford, A. et al. *The St. Martin's Handbook for Canadians.* Nelson Canada, 1991. [handbook]

ISBN 0176034935

Nagarajan, S. (ed.) *Measure for Measure.* New American Library, 1964. [Shakespeare]

ISBN 0198319339

Oster, J. E. et al. *Literary Experiences Volume One.* Prentice Hall Canada, 1989. [multigenre]

ISBN 0135377625

Rosen, G. et al. *The Story Begins When the Story Ends: Canadian and World Short Story Fiction.* Prentice Hall Canada, 1991. [short stories]

ISBN 0138472785

Saliani, D. *Poetry Alive: Perspectives.* Copp Clark Pitman Ltd., 1991. [poetry]

ISBN 0773051473

Weaver et al. *Oxford Anthology of Canadian Literature.* Second edition. Oxford University Press, 1981. [multigenre]

ISBN 0195403762

West, W. W. et al. *Developing Writing Skills.* Third Canadian edition. Prentice Hall, 1981. [composition and language]

ISBN 0132053284

Nonprint

Claris. *Apple Works.* Version 3.0, 1989. [computer courseware]

Microsoft Canada. *Microsoft Word.* [computer courseware]
IBM Version 5.5, 1990
IBM Version 6.0, 1993
Macintosh Version 4.0, 1989

Microsoft Canada Inc. *Microsoft Word for Windows.* [computer courseware]
IBM Version 2.0, 1992

Microsoft Corporation. *Microsoft Works.* [computer courseware]
IBM Version 2.0, 1989
Macintosh Version 2.0a, 1989

WordPerfect Corporation. *WordPerfect.* [computer courseware]
Apple IIGS Version 2.1, 1990
IBM Version 5.1, 1990
Macintosh Version 2.0, 1990

ENGLISH 30

Print

Barker–Sandbrook, Judith. *Essays: Patterns and Perspectives.* Oxford University Press, 1992. [nonfiction]

ISBN 019540839X

Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt Canada, 1991. [composition and language]

ISBN 0774731443

Cameron, B. *On Stage 3.* Globe Modern, 1984. [modern drama]

ISBN 0889960984

Conrad, R. *The Act of Writing: Canadian Essays for Composition.* Third edition. McGraw-Hill Ryerson, 1990. [nonfiction]

ISBN 0075497921

_____. *The Act of Writing: Canadian Essays for Composition.* Revised third edition. McGraw-Hill Ryerson, 1993. [nonfiction]

ISBN 0075517116

Davies, R. and G. Kirkland. *Inside Poetry.* Academic Press Canada/HBJ-Holt, 1987. [poetry]

ISBN 0774712244

Eisenstat, M. (ed.) *Hamlet.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712686

Gehle, Q. L. and D. J. Rollo. *The Writing Process.* Canadian edition. Nelson Canada, 1981. [composition and language]

ISBN 0176015310

Gill, R. (ed.) *Hamlet.* Oxford University Press, 1992. [Shakespeare]

ISBN 0198319606

_____. *Henry IV: Part I.* Revised edition. Oxford University Press, 1993. [Shakespeare]

ISBN 019831969X

Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

ISBN 017603515X

Iveson, M. L. et al. *Literary Experiences Volume Two.* Prentice Hall Canada, 1990. [multigenre]

ISBN 0135381584

Kirkland, G. and R. Davies. *Inside Stories for Senior Students.* Harcourt Brace Jovanovich, Canada, 1993. [short stories]

ISBN 0774714085

Landy, A. S. et al. *Heath Introduction to Literature.* Canadian edition. D. C. Heath Canada, 1982. [multigenre]

ISBN 0669950416

Liffiton, L. and J. McAllister. *Poetry Alive: Reflections.* Copp Clark Pitman, 1993. [poetry]

ISBN 0773051678

Lunsford, A. et al. *The St. Martin's Handbook for Canadians.* Nelson Canada, 1991. [handbook]

ISBN 0176034935

Mills, I. W. and J. H. Mills. *Arch of Experience.* Holt, Rinehart and Winston, 1987. [multigenre]

ISBN 003922032X

Patenaude, A. (ed.) *The Tempest.* HBJ-Holt, 1990. [Shakespeare]

ISBN 0774713593

Perrine, L. *Story and Structure.* Canadian edition. HBJ-Holt-Saunders, 1987. [short stories]

ISBN 0774711957

Roy, K. (ed.) *King Lear.* HBJ-Holt, 1990. [Shakespeare]

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Taube, E. *Seasons of Life: Stories of the Human Cycle.* McClelland and Stewart, 1985. [short stories]

ISBN 0771084404

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Claris. *AppleWorks.* Version 3.0, 1989.
[computer courseware]

Microsoft Canada. *Microsoft Word.*
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Macintosh Version 4.0, 1989

Microsoft Canada Inc. *Microsoft Word for Windows.*
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IBM Version 2.0, 1992

Microsoft Corporation. *Microsoft Works.*
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IBM Version 2.0, 1989
Macintosh Version 2.0a, 1989

WordPerfect Corporation. *WordPerfect.*
[computer courseware]
Apple IIGS Version 2.1, 1990
IBM Version 5.1, 1990
Macintosh Version 2.0, 1990

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Print

Banel, J. S. et al. *More Strawberries: Reflections in Fiction.* Nelson Canada, 1990. [short stories]

ISBN 0176030441

Barry, J. *Departures: Reflections in Poetry.* Nelson Canada, 1991. [poetry]

ISBN 0176037179

Brodkin, S. Z. and E. J. Pearson. *Seven Plays of Mystery and Suspense.* Globe Modern, 1982. [modern drama]

ISBN 0870653180

Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt Canada, 1991. [composition and language]

ISBN 0774731443

Davies, R. and G. Kirkland. *Connections 1: Imagining.* Second edition. Gage, 1990. [multigenre]

ISBN 0771511043

Eaton, D. F. *On Cue 1.* HBJ-Holt, 1990. [modern drama]

ISBN 0774713682

Gill, R. (ed.) *The Merchant of Venice.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319738

_____. *Romeo and Juliet.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 019831972X

_____. *Twelfth Night.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319746

Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

ISBN 017603515X

MacNeill, J. A. *Early September.* Nelson Canada, 1980. [short stories]

ISBN 0176007490

Maitman, M. and I. Waldron (eds.). *The Merchant of Venice.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712635

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ISBN 0774713659

McClymont, C. *Viewpoints: Reflections in Non-Fiction.* Nelson Canada, 1990. [nonfiction]

ISBN 0176030972

McClymont, C. et al. *Features Series.* Nelson Canada, 1993. [multigenre]

Spotlight on You, Book 1
ISBN 0176039635

Out of the Shadows, Book 2
ISBN 0176039643

Meet the Challenge, Book 3
ISBN 0176039651

Robinson, S. D. *Destinations Series.* Prentice Hall Canada, 1990. [multigenre]

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ISBN 0130051829

Roy, K. (ed.) *Romeo and Juliet.* HBJ-Holt, 1987. [Shakespeare]

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Claris. *AppleWorks.* Version 3.0, 1989. [computer courseware]

Microsoft Canada. *Microsoft Word.*
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Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt, 1991. [composition and language]

ISBN 0774731443

Cameron, B. *On Stage 2.* Globe Modern, 1984. [modern drama]

ISBN 0889960968

Davies, R. and G. Kirkland. *Connections 2: Relating.* Second edition. Gage, 1990. [multigenre]

ISBN 077151106X

Eaton, D. F. *On Cue 2.* HBJ-Holt, 1991. [modern drama]

ISBN 0774713690

Elchuk, A. *Destinations Series.* Prentice Hall Canada, 1990. [multigenre]

Straight Ahead [text]
ISBN 0138518335

Overdrive, 1991 [anthology]
ISBN 0136475469

Gill, R. (ed.) *As You Like It.* Oxford University Press, 1977. [Shakespeare]

ISBN 0198319347

_____. *Macbeth.* Revised edition. Oxford University Press, 1992. [Shakespeare]

ISBN 0198319703

Gough, N. and G. Tickner. *Language at Work.* HBJ-Holt, 1986. [composition and language]

ISBN 0039220311

Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

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Kortes, M. (ed.) *Macbeth.* HBJ-Holt, 1988. [Shakespeare]

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IBM Version 6.0, 1993
Macintosh Version 4.0, 1989

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Macintosh Version 2.0a, 1989

WordPerfect Corporation. *WordPerfect.*
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IBM Version 5.1, 1990
Macintosh Version 2.0, 1990

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Buckley, J. *Fit to Print: The Canadian Student's Guide to Essay Writing.* Second edition. HBJ-Holt Canada, 1991. [composition and language]

ISBN 0774731443

Cameron, B. *On Stage 3.* Globe Modern, 1984. [modern drama]

ISBN 0889960984

Davies, R. and G. Kirkland. *Connections 3: Discovering.* Second edition. Gage, 1990. [multigenre]

ISBN 0771511086

Eisenstat, M. (ed.) *Hamlet.* HBJ-Holt, 1988. [Shakespeare]

ISBN 0774712686

Gill, R. (ed.) *Hamlet.* Oxford University Press, 1992. [Shakespeare]

ISBN 0198319606

_____. *Othello.* Oxford University Press, 1989. [Shakespeare]

ISBN 0198319535

_____. *The Taming of the Shrew.* Revised edition. Oxford University Press, 1992. [Shakespeare]

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Hacker, D. *A Canadian Writer's Reference.* Nelson Canada, 1990. [handbook]

ISBN 017603515X

MacNeill, J. A. et al. *Tigers of the Snow.* Nelson, 1973. [short stories]

ISBN 0176330437

Robinson, S. D. et al. *Destinations Series*. Prentice Hall Canada, 1991. [multigenre]

In Flight [text]
ISBN 0134561538

Glide Path [anthology]
ISBN 0133562476

Nonprint

Claris. *AppleWorks.* Version 3.0, 1989.
[computer courseware]

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[computer courseware]
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IBM Version 6.0, 1993
Macintosh Version 4.0, 1989

Microsoft Canada Inc. *Microsoft Word for Windows.*
[computer courseware]
IBM Version 2.0, 1992

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Macintosh Version 2.0a, 1989

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IBM Version 5.1, 1990
Macintosh Version 2.0, 1990

MATHEMATICS 31

A. COURSE OVERVIEW

RATIONALE

To set goals and make informed choices, students need an array of thinking and problem-solving skills. Fundamental to this is an understanding of mathematical techniques and processes that will enable them to apply the basic skills necessary to address everyday mathematical situations, as well as acquire higher order skills in logical analyses and methods for making valid inferences.

A knowledge of mathematics is essential to a well-educated citizenry. However, the need for and use of mathematics in the life of the average citizen are changing. **Emphasis has shifted from the memorization of mathematical formulas and algorithms toward a dynamic view of mathematics as a precise language of terms and symbolic notation, used to describe, reason, interpret and explore.** There is still a need for the logical development of concepts and skills as a basis for the appropriate use of mathematical information to solve problems. Problem-solving strategies, combined with techniques such as estimation and simulation, and incorporated with modern technology, are the tools with which mathematical problems are solved.

Students need procedural competence with numbers and operations, together with a facility in basic algebraic operations and an understanding of fundamental mathematical concepts. They also need to understand the connections among related concepts and be familiar with their use in relevant applications. Students must be able to solve problems, using the mathematical processes developed, and be confident in their ability to apply known mathematical skills and concepts in the acquisition of new mathematical knowledge. In addition, the ability of technology to provide quick and accurate computation and manipulation, to enhance conceptual understanding and to facilitate higher order thinking, should be recognized and used by students.

Mathematics programs must anticipate the changing needs of society, and provide students with the mathematical concepts, skills and attitudes necessary to cope with the challenges of the future.

The majority of students who are enrolled in senior high school mathematics have not yet completely internalized formal thinking with regard to mathematics. They are expected to acquire much abstract understanding in senior high school mathematics courses. The content of each course in the mathematics program is designed to be cognitively appropriate and presented in a way that is consistent with the students' abilities to understand.

The senior high school mathematics program includes the course sequences:

- Mathematics 10–20–30 and Mathematics 31
- Mathematics 13–23–33
- Mathematics 14–24
- Mathematics 16–26.

Mathematics 31 is generally taken after Mathematics 30; however, Mathematics 31 and Mathematics 30 may be taken concurrently.

Mathematics 10–20–30 and Mathematics 31 are designed for students who have achieved the acceptable standard in Mathematics 9, and who are intending to pursue studies beyond high school at a university or in a mathematics-intensive program at a technical school or college. Mathematics 10–20–30 emphasizes the theoretical development of topics in algebra, geometry, trigonometry and statistics up to a level acceptable for entry into such programs.

Having successfully achieved the acceptable standard in each of Mathematics 10, Mathematics 20 and Mathematics 30, students will have met or exceeded the basic mathematics entry requirements for most university or university transfer programs, and will have met or exceeded all mathematics entry requirements for technical school or college programs. A significant number of students would benefit by taking a course in calculus, thus improving their opportunity for success in higher level courses in mathematics at university, such as those required by mathematics and physics honours programs, or by engineering and business programs.

Mathematics 31 emphasizes the theoretical and practical development of topics in the algebra of functions, trigonometry, differential calculus and integral calculus up to a standard acceptable for entry into all first-year programs in mathematics, science, engineering and business. The course is designed to bridge the gap between the Mathematics 10–20–30 course sequence and the calculus course sequences offered by post-secondary institutions.

GOALS

As a culmination of the Mathematics 10–20–30 and Mathematics 31 course sequence, the **specific purposes** of the Mathematics 31 course of studies are as follows:

- to develop an understanding of the algebra of functions and transformations, together with their graphs, and to apply these understandings in different areas of mathematics
- to develop a fluency in algebraic computations involving rational expressions, inequalities, absolute values and trigonometric functions
- to introduce the principal concepts and methods of differential and integral calculus
- to develop skills in problem solving and reasoning, using calculus concepts and procedures as the context
- to apply the methods of calculus to various simple applications in the physical and biological sciences, in engineering, in business and in the social sciences.

PHILOSOPHY

Following the principles elaborated in the *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989, the major focuses of the Mathematics 31 course of studies are on **attitudes**, **problem solving**, **communication**, **reasoning**, **connections** and **technology**. In this document, the term **mathematical processes** is used to make reference to these focuses. Further elaborations of these focuses are given below.

Attitudes

Students are expected to develop an appreciation for the beauty and power of mathematics as a method of solving problems and as an expression of human thought. From this appreciation, they should respect evidence and data, show open-mindedness toward the points of view of others, endeavour to be creative in thinking, persevere in the face of difficulties, be curious in their view of the world, and show a desire to understand. They should show respect for and appreciation of the roles of science and technology in the learning and doing of mathematics.

Problem Solving

Students develop a deep understanding of mathematical concepts and procedures when they solve problems related to practical contexts, to contexts within mathematics itself, and to other school subjects. Students are expected to decide on which concepts and procedures are likely to be useful in solving a particular problem, plan the appropriate application of concepts and procedures to the situation, carry out the plan, and evaluate the reasonableness of the solution and solution procedure when the task is complete. They should then be expected to modify the solution procedure to solve a closely related problem, or apply the solution procedure to a new situation.

Communication

As well as being expected to construct solutions to problems, students are expected to communicate both solutions and solution procedures. They are expected to communicate the representations used for concepts, any approximations or limitations that are inherent in the solution, the reliability of the final solution, and the reasons why particular methods were used. These communications may be oral or written. Students should be able to use the language and symbolism of mathematics appropriately.

Reasoning

A major part of mathematics is reasoning. Students are expected to analyze situations, make assumptions, make and test conjectures, draw conclusions and justify solution procedures. The level of reasoning may vary from speculative to formally rigorous, and students are expected to be able to reason at all of these levels, depending on the context and the purpose set in the problem.

Connections

Students are expected to make connections among mathematics concepts, between mathematics and other school subjects, and between mathematics and everyday life. They are required especially to link new learning to the mathematics they already know, and to apply both old and new mathematics to a wide variety of problem situations. They are expected to make connections between algebraic and geometric representations, and between numerical and symbolic methods. In addition, they are expected to be able to communicate and justify the connections made in a problem solution.

Technology

Students are expected to be aware of the capabilities of various technologies, such as scientific calculators, including those with graphing capabilities; graphing computer software and productivity software, such as word processing, spreadsheet, database and symbol manipulation programs. From this awareness, students are expected to use technology appropriate to the task at hand. Besides the use of technology for precise solutions, students are expected to provide estimates, approximations and sketches, using pencil and paper methods, with no technological aids.

EXPECTATIONS

Students are expected to be mathematically literate at the conclusion of their senior high school mathematics education. **Mathematical literacy** refers to students' abilities and inclinations to manage the demands of their world through the use of mathematical concepts and procedures to solve problems, communicate and reason. More specifically, *students will be expected to:*

- have developed the concepts, skills and attitudes that will enable the acquisition of mathematical knowledge beyond the conclusion of secondary education
- have developed the concepts, skills and attitudes that will ensure success in mathematical situations that occur in future educational endeavours, employment and everyday life
- have achieved understanding of the basic mathematical concepts, and developed the skills and attitudes needed to become responsible and contributing members of society

- apply basic mathematical concepts and skills in practical situations
- have developed critical and creative thinking skills
- communicate mathematical ideas effectively
- understand how mathematics can be used to investigate, interpret and make decisions in human affairs
- understand how mathematics can be used in the analyses of natural phenomena
- understand the connections and interplay among various mathematical concepts and between mathematics and other disciplines
- understand and appreciate the positive contributions of mathematics, as a science and as an art, to civilization and culture.

B. LEARNER EXPECTATIONS

COURSE FOCUS

The Mathematics 31 course is designed to introduce students to the mathematical methods of calculus. The course acts as a link between the outcomes of the Mathematics 10–20–30 program and the requirements of the mathematics encountered in post-secondary programs. The course builds on existing skills in working with functions and expands this knowledge to include a study of limits in preparation for a study of differential and integral calculus. The methods of calculus are applied to problems encountered in the areas of science, engineering, business and other fields of endeavour.

The focus of the course is to examine functions that describe changing situations as opposed to the more static situations encountered in previous mathematics courses. Emphasis is placed on using graphical methods to illustrate the way in which changing functions behave.

COURSE STRUCTURE

Mathematics 31 is designed in a required–elective format. The **required component** is intended to take the larger proportion of the instructional time. There are eight units available in the **elective component**, of which one or more units are intended to take the remainder of the instructional time.

The time given to the required component, and the number of elective units covered, will vary, depending on local needs. In general, most students will do one or two elective units; however, some students must do as many as four in order to integrate the requirements of external agencies into the Mathematics 31 course.

Required Component

The four sections of the required component are as follows:

- precalculus and limits
- derivatives and derivative theorems
- applications of derivatives
- integrals, integral theorems and integral applications.

Elective Component

The eight possible units available in the elective component are as follows:

- calculus of exponential and logarithmic functions
- numerical methods
- volumes of revolution
- applications of calculus to physical sciences and engineering
- applications of calculus to biological sciences
- applications of calculus to business and economics
- calculus theorems
- further methods of integration.

COURSE LEARNER EXPECTATIONS

The learner expectations found on pages 8 through 51 are the required student outcomes at the end of the Mathematics 31 course. **They do not serve as a required sequence for instruction.** The sequence for instruction will vary, depending on the mathematical background of the students, the learning resources being used, and the preferences of individual teachers.

The learner expectations are divided into *course general learner expectations* and *related specific learner expectations*.

The *course general learner expectations* for Mathematics 31, on pages 8 and 9, provide a bridge between the philosophy statements for all senior high school mathematics courses and the *related specific learner expectations* for each section or unit of study.

The *related specific learner expectations* refer to particular areas of study, such as limits and antiderivatives. They are on pages 10 through 35 for the **required component**, and on pages 36 through 51 for the **elective component**.

Learner expectations are organized into five concept strands, each with three outcome columns. The strands are identified as Mathematical Processes, Measurement and Geometry, Algebra of Functions and Limits, Calculus of Derivatives and Integrals, and Data

Management. The outcomes are organized under Conceptual Understanding, Procedural Knowledge and Problem-solving Contexts.

Although itemized separately, the outcomes are meant to be developed together, using an appropriate balance for the content being studied, and applying the learnings in an appropriate context.

Strands

The strand, **Mathematical Processes**, describes problem-solving, communication and reasoning strategies that apply to many areas of mathematics. Examples include the construction and use of mathematical models and the proper use of approximation techniques for difficult calculations.

In the context of the Mathematics 31 course, mathematical processes include the making and testing of conjectures, the comparison of numerical and algebraic solutions, the connections between similar solution procedures and completely different problems, and the differences between intuitive and rigorous proofs.

The strand, **Measurement and Geometry**, describes the mathematics of spatial reasoning. Measurement involves associating numerical values to various geometrical properties of one-, two- or three-dimensional figures while the geometry involves the properties of one-, two- or three-dimensional figures, and the geometrical representation of domains, limits, derivatives and integrals.

In the context of the Mathematics 31 course, measurement and geometry involve the generalizations of the concepts of slope, curve, line and average to contexts characterized by change, and to contexts where the traditional descriptions give misleading interpretations.

The strand, **Algebra of Functions and Limits**, describes the generalization of patterns, and its description in ordered pair, symbolic and geometrical forms.

In the context of the Mathematics 31 course, the algebra of functions and limits represents an extension of algebraic concepts to enable algebraic models to be used in contexts where functions may not exist, or may be discontinuous.

The strand, **Calculus of Derivatives and Integrals**, describes the extension of algebra to situations that model change.

In the context of the Mathematics 31 course, the calculus of derivatives and integrals refers only to the differential and integral calculus of relations and functions of a single, real variable. The emphasis is more on the use and application of derivatives, and less on the use and application of integrals.

The strand, **Data Management**, describes the mathematics of information processing, from the description of simple data sets to the making of predictions based on models constructed from the data.

In the context of the Mathematics 31 course, data management is confined to the generalization of the concepts of average value and equation root, together with the development of tools that can compute numerical approximations to any desired degree of accuracy. The calculus of random variables is not part of Mathematics 31, though the calculus methods developed in Mathematics 31 could be used in the context of a random variable and its associated probability distribution.

Outcomes

The **Conceptual Understanding** outcomes refer to the major concepts involved in the development of understanding the algebra of functions, the establishment of limits, the differential calculus and the integral calculus.

Conceptual expectations are characterized by the use of such action verbs as *defining, demonstrating, describing, developing, establishing, explaining, giving, identifying, illustrating, linking, recognizing and representing.*

The **Procedural Knowledge** outcomes refer to the development of fluency in carrying out procedures related to the general learner expectations. Examples of such procedures are those used for the computation of limits, derivatives and integrals, the determination of maxima and minima, and the computation of average values of functions over intervals.

Procedural expectations are characterized by the use of such action verbs as *approximating, calculating, constructing, differentiating, estimating, factoring, locating, rationalizing, simplifying, sketching, solving, using* and *verifying.*

The **Problem-solving Contexts** outcomes refer to the construction of models describing applications in a broad range of contexts. They also refer to the combination of algorithms to determine more complicated combinations of limits, derivatives and integrals, and to the use of appropriate technology to approximate difficult models or to carry out long, computational procedures. They also refer to the investigation of phenomena, the collection and interpretation of data in various contexts, and the transfer of knowledge from mathematics to other areas of human endeavour.

Problem-solving expectations are characterized by the use of such action verbs as *adapting, analyzing, combining, communicating, comparing, connecting, constructing, deriving, evaluating, fitting, investigating, justifying, modelling, proving, reconstructing* and *translating.*

COURSE GENERAL LEARNER EXPECTATIONS BY STRAND

STRANDS	CONCEPTUAL UNDERSTANDING
	Students will demonstrate understanding of the concepts of Mathematics 31, by:
Mathematical Processes Mastery of *course* expectations enables students to construct and solve models describing mathematical situations in a broad range of contexts, and to use the appropriate technology to approximate difficult models and carry out long calculations.	• identifying and giving examples of the strengths and limitations of the use of technology in the computation of limits, derivatives and integrals • giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals.
Measurement and Geometry Mastery of *course* expectations enables students to demonstrate the conceptual underpinnings of calculus to determine limits, derivatives, integrals, rates of change and averages, using geometrical representations.	• describing the relationships among functions after performing translations, reflections, stretches and compositions on a variety of functions • linking displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity.
Algebra of Functions and Limits Mastery of *course* expectations enables students to translate among symbolic, diagram and graphical representations of situations that describe both continuous and discrete functions of one real variable.	• giving examples of the limits of functions and sequences, both at finite and infinite values of the independent variable.
Calculus of Derivatives and Integrals Mastery of *course* expectations enables students to determine limits, derivatives, integrals and rates of change.	• connecting the derivative with a particular limit, and expressing this limit in situations like secant and tangent lines to a curve • relating the derivative of a complicated function to the derivative of simpler functions • relating the zeros of the derivative function to the critical points on the original curve • recognizing that integration can be thought of as an inverse operation to that of finding derivatives.
Data Management Mastery of *course* expectations enables students to use calculus concepts to describe data distributions and random variables at an introductory level.	• describing the connections between the operation of integration and the finding of areas and averages.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures of Mathematics 31, by:	*Students will* demonstrate problem-solving skills in Mathematics 31, by:
• combining and modifying familiar solution procedures to form a new solution procedure to a related problem.	• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem • producing approximate answers to complex calculations by simplifying the models used.
• drawing the graphs of functions by applying transformations to the graphs of known functions • calculating the displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity.	• constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change.
• expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand • computing limits of functions, using definitions, limit theorems and calculator/computer methods.	• constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable.
• computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods • computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods.	• determining the optimum values of a variable in various contexts, using the concepts of maximum and minimum values of a function • using the concept of critical values to sketch the graphs of functions, and comparing these sketches to computer-generated plots of the same functions • connecting a derivative and the appropriate rate of change, and using this connection to relate complicated rates of change to simpler ones.
• calculating the mean value of a function over an interval.	• fitting mathematical models to situations described by data sets.

RELATED SPECIFIC LEARNER EXPECTATIONS FOR REQUIRED COMPONENT

PRECALCULUS AND LIMITS (Required)

Overview

The first parts of this Mathematics 31 section are designed to reinforce and extend algebraic and trigonometric skills. The algebra of functions introduced in Mathematics 20 and applied to exponential, logarithmic, trigonometric and polynomial functions in Mathematics 30 is extended to the general function. Algebraic and geometric representations of transformations are used. The skills acquired are a necessary adjunct to all work in the Mathematics 31 course. The last part concentrates on the numerical and geometrical development of the concepts of limits and limit theorems.

Student Outcomes Summary

After completing this section, students will be expected to have acquired reliability and fluency in the algebraic skills of factoring, operations with radicals and radical expressions, coordinate geometry, and transformation of functions. They will also be expected to solve linear, quadratic and absolute value inequalities, and to solve trigonometric equations and identities. They will be expected to express the concept of a limit numerically and geometrically, and to calculate limits, using first principles and the limit theorems.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that functions, as well as variables, can be combined, using operations, such as addition and multiplication, and demonstrate this, by: • describing the relationship among functions after performing translations, reflections, stretches and compositions on a variety of functions • drawing the graphs of functions by applying transformations to the graphs of known functions • expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand • constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable.	*Students will* demonstrate conceptual understanding of the algebra of functions, by: • illustrating different notations that describe functions and intervals • expressing, in interval notation, the domain and range of functions • expressing the sum, product, difference and quotient, algebraically and graphically, given any two functions • expressing, algebraically and graphically, the composition of two or more functions • illustrating the solution sets for linear, quadratic and absolute value inequalities $\|P(x)\| \geq a$ $\|P(x)\| \leq a$ $ax^2 + bx + c \geq d$ • illustrating the difference between the concepts of equation and identity in trigonometric contexts.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the algebra of functions, by:	*Students will* demonstrate problem-solving skills, by:
• using open, closed and semi-open interval notation	• modelling problem situations, using sums, differences, products and quotients of functions
• finding the sum, difference, product, quotient and composition of functions	• investigating the connections between the algebraic form of a function $f(x)$ and the symmetries of its graph.
• solving inequalities of the types $\lvert P(x)\rvert \geq a$ $\quad \left\lvert \frac{P(x)}{Q(x)} \right\rvert \geq a$ $\lvert P(x)\rvert \leq a$ $\frac{P(x)}{Q(x)} \geq a$ $\quad ax^2+bx+c \geq d$	
• using the following trigonometric identities: • primary and reciprocal ratio • double and half angle • sum and difference $\sin(A \pm B)$ $\cos(A \pm B)$ • Pythagorean to simplify expressions and solve equations, express sums and differences as products, and rewrite expressions in a variety of equivalent forms.	

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that functions can be transformed, and these transformations can be represented algebraically and geometrically, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the transformation of functions, by:
• describing the relationship among functions after performing translations, reflections, stretches and compositions on a variety of functions	• describing the similarities and differences between the graphs of $y=f(x)$ and $y=af[k(x+c)]+d$, where a, k, c and d are real numbers
• drawing the graphs of functions by applying transformations to the graphs of known functions	• describing the effects of the reflection of the graphs of algebraic and trigonometric functions across any of the lines $y=x$, $y=0$, or $x=0$
• expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand	• describing the effects of the parameters a, b, c and d on the trigonometric function $f(x)=a\sin[b(x+c)]+d$
• constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable.	
	• describing the relationship between parallel and perpendicular lines
	• describing the condition for tangent, normal and secant lines to a curve
	• linking two problem conditions to a system of two equations for two unknowns.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the transformation of functions, by:	*Students will* demonstrate problem-solving skills, by:

• sketching the graph of, and describing algebraically, the effects of any translation, reflection or dilatation on any of the following functions or their inverses:
  • linear, quadratic or cubic polynomial
  • absolute value
  • reciprocal
  • exponential
  • step
• sketching and describing, algebraically, the effects of any combination of translation, reflection or dilatation on the following functions:
  • $f(x)=a\sin[b(x+c)]+d$
  • $f(x)=a\cos[b(x+c)]+d$
  • $f(x)=a\tan[b(x+c)]$
	• translating problem conditions into equation or inequality form.

• finding the equation of a line, given any two conditions that serve to define it • solving systems of linear–linear, linear–quadratic or quadratic–quadratic equations.	

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that final answers may be expressed in different equivalent forms, and demonstrate this, by: • giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals • expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand.	*Students will* demonstrate conceptual understanding of equivalent forms, by: • describing what it means for two algebraic or trigonometric expressions to be equivalent.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the construction of equivalent forms, by: • factoring expressions with integral and rational exponents, using a variety of techniques • rationalizing expressions containing a numerator or a denominator that contains a radical • simplifying rational expressions, using any of the four basic operations.	*Students will* demonstrate problem-solving skills, by: • illustrating the difference between verification and proof in the comparison of two algebraic or trigonometric expressions.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that descriptions of change require a careful definition of limit and the precise use of limit theorems, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of limits and limit theorems, by:
• identifying and giving examples of the strengths and limitations of the use of technology in the computation of limits, derivatives and integrals	• explaining the concept of a limit • giving examples of functions with limits, with left-hand or right-hand limits, or with no limit
• giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals	• giving examples of bounded and unbounded functions, and of bounded functions with no limit
• giving examples of the limits of functions and sequences, both at finite and infinite values of the independent variable	• explaining, and giving examples of, continuous and discontinuous functions
• computing limits of functions, using definitions, limit theorems and calculator/ computer methods.	• defining the limit of an infinite sequence and an infinite series
	• explaining the limit theorems for sum, difference, multiple, product, quotient and power • illustrating, using suitable examples, the limit theorems for sum, difference, multiple, product, quotient and power.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with limits and limit theorems, by:	*Students will* demonstrate problem-solving skills, by:
• determining the limit of any algebraic function as the independent variable approaches finite or infinite values for continuous and discontinuous functions • sketching continuous and discontinuous functions, using limits, intercepts and symmetry	• proving and illustrating geometrically, the following trigonometric limits: $\lim_{x\to 0} \frac{\sin x}{x}$ or $\lim_{x\to 0} \frac{x}{\sin x} = 1$ AND $\lim_{x\to 0} \frac{\cos x - 1}{x} = 0$
• calculating the sum of an infinite convergent geometric series	• using the basic trigonometric limits, combined with limit theorems, to determine the limits of more complex trigonometric expressions
• using definitions and limit theorems to determine the limit of any algebraic function as the independent variable approaches a fixed value • using definitions and limit theorems to determine the limit of any algebraic function as the independent variable approaches $\pm\infty$.	• comparing numerical and algebraic processes for the determination of algebraic and trigonometric limits.

DERIVATIVES AND DERIVATIVE THEOREMS (Required)

Overview

The concept of the slope of a line can be extended to give students an intuitive feel for the meaning of slope at a point on a curve. By examining slopes of secants, and using the ideas of limits, the derivative can be put into a well-defined form. Derivative theorems are used to find only the derivatives of algebraic and trigonometric functions.

Student Outcomes Summary

After completing this section, students will be expected to find derivatives of algebraic and trigonometric functions and determine equations of tangents at specific points. For selected functions, they will also be expected to prove these derivatives, using first principles. Students use the power, chain, product and quotient rules to calculate the derivatives of these functions. They will also be expected to use implicit differentiation to find the derivatives of certain algebraic and trigonometric relations.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that the derivative of a function is a limit that can be found, using first principles, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of derivatives, by:
• giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals	• showing that the slope of a tangent line is a limit
• connecting the derivative with a particular limit, and expressing this limit in situations like secant and tangent lines to a curve	• explaining how the derivative of a polynomial function can be approximated, using a sequence of secant lines
• computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods.	• explaining how the derivative is connected to the slope of the tangent line
	• recognizing that $f(x)=x^n$ can be differentiated where $n \in R$
	• identifying the notations $f'(x)$, y', and $\frac{dy}{dx}$ as alternative notations for the first derivative of a function
	• explaining the derivative theorems for sum and difference $(f \pm g)'(x)=f'(x) \pm g'(x)$
	• explaining the sense of the derivative theorems for sum and difference, using practical examples.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with derivatives, by:	*Students will* demonstrate problem-solving skills, by:
• finding the slopes and equations of tangent lines at given points on a curve, using the definition of the derivative	• deriving $f'(x)$ for polynomial functions up to the third degree, using the definition of the derivative
• estimating the numerical value of the derivative of a polynomial function at a point, using a sequence of secant lines	• using the definition of the derivative to find $f'(x)$ for $f(x)=(ax+c)^n$ where $n=-1$ or $n=\frac{1}{2}$.
• using the definition of the derivative to determine the derivative of $f(x)=x^n$ where n is a positive integer	
• differentiating polynomial functions, using the derivative theorems for sum and difference	
• differentiating functions that are single terms of the form x^n where n is rational.	

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that derivatives of more complicated functions can be found from the derivatives of simpler functions, using derivative theorems, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of derivative theorems, by:
• giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals	• demonstrating that the chain, power, product and quotient rules are aids to differentiate complicated functions
• relating the derivative of a complicated function to the derivative of simpler functions	• identifying implicit differentiation as a tool to differentiate functions where one variable is difficult to isolate
• expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand	• explaining the relationship between implicit differentiation and the chain rule
• computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods.	• comparing the sum, difference, product and quotient theorems for limits and derivatives
	• explaining the derivation of the derivative theorems for product and quotient $(fg)'(x) = f'(x)\,g(x) + f(x)\,g'(x)$ $\left(\frac{f}{g}\right)'(x) = \frac{f'(x)\,g(x) - f(x)\,g'(x)}{[g(x)]^2}$
	• explaining the derivative theorems for product and quotient, using practical examples
	• illustrating second, third and higher derivatives of algebraic functions
	• describing the second derivative geometrically.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with derivative theorems, by:	*Students will* demonstrate problem-solving skills, by:
• finding the derivative of a polynomial, power, product or quotient function • applying the chain rule in combination with the product and quotient rule • using the technique of implicit differentiation	• deriving the quotient rule from the product rule • showing that equivalent forms of the derivative of a rational function can be found by using the product and the quotient rules • determining the derivative of a function expressed as a product of more than two factors
• writing final answers in factored form • finding the slope and equations of tangent lines at given points on a curve	• determining the second derivative of an implicitly defined function AND, in one or more of the following, by: • showing the derivative for a relation found by both implicit and explicit differentiation to be the same • finding the equations of tangent lines to the standard conics.
• finding the second and third derivatives of functions.	

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that trigonometric functions have derivatives, and these derivatives obey the same derivative theorems as algebraic functions, and demonstrate this, by: • identifying and giving examples of the strengths and limitations of the use of technology in the computation of limits, derivatives and integrals • giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals • relating the derivative of a complicated function to the derivative of simpler functions • computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods.	*Students will* demonstrate conceptual understanding of the derivatives of trigonometric functions, by: • demonstrating that the three primary trigonometric functions have derivatives at all points where the functions are defined • explaining how the derivative of a trigonometric function can be approximated, using a sequence of secant lines.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with derivatives of trigonometric functions, by:	*Students will* demonstrate problem-solving skills, by:
• calculating the derivatives of the three primary and three reciprocal trigonometric functions • estimating the numerical value of the derivative of a trigonometric function at a point, using a sequence of secant lines • using the power, chain, product and quotient rules to find the derivatives of more complicated trigonometric functions • using the derivative of a trigonometric function to calculate its slope at a point, and the equation of the tangent at that point.	• using the definition of the derivative to find the derivative for the sine and cosine functions • explaining why radian measure has to be used in the calculus of trigonometric functions.

APPLICATIONS OF DERIVATIVES (Required)

Overview

Inside the area of pure mathematics, graph sketching of polynomial functions, rational algebraic functions and simple trigonometric functions are looked at. Derivatives are used to solve maximum and minimum problems in economic and geometrical contexts and to solve related rate problems in geometrical and algebraic contexts.

Student Outcomes Summary

After completing this section, students will be expected to provide systematic sketches of graphs of polynomial, rational, algebraic and trigonometric functions of one variable. They will be expected to solve maximum–minimum and related rate problems in economic and geometric contexts. They will be expected to construct maximum–minimum and related rate models in geometric contexts, and to use the techniques of derivatives to solve problems based on the models constructed.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that calculus is a powerful tool in determining maximum and minimum points and in sketching of curves, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of maxima and minima, by:
• relating the zeros of the derivative function to the critical points on the original curve	• identifying, from a graph sketch, locations at which the first and second derivative are zero
• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem	• illustrating under what conditions symmetry about the x-axis, y-axis or the origin will occur
• constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable	• explaining how the sign of the first derivative indicates whether or not a curve is rising or falling; and by explaining how the sign of the second derivative indicates the concavity of the graph
• determining the optimum values of a variable in various contexts, using the concepts of maximum and minimum values of a function	• illustrating, by examples, that a first derivative of zero is one possible condition for a maximum or a minimum to occur
• using the concept of critical values to sketch the graphs of functions, and comparing these sketches to computer-generated plots of the same functions	• explaining circumstances wherein maximum and minimum values occur when $f'(x)$ is not zero
• fitting mathematical models to situations described by data sets.	• illustrating, by examples, that a second derivative of zero is one possible condition for an inflection point to occur
	• explaining the differences between local maxima and minima and absolute maxima and minima in an interval
	• explaining when finding a maximum value is appropriate and when finding a minimum value is appropriate.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with maxima and minima, by:	*Students will* demonstrate problem-solving skills, by:
• sketching the graphs of the first and second derivative of a function, given its algebraic form or its graph • using zeros and intercepts to aid in graph sketching	• employing a systematic calculus procedure to sketch algebraic and trigonometric functions • comparing and contrasting graphs plotted on a calculator and graphs sketched, using a systematic calculus procedure • calculating maxima and minima for such quantities as volumes, areas, perimeters and costs • illustrating the connections among geometric, economic or motion problems, the modelling equations of these problems, the resulting critical points on the graphs and their solutions, using derivatives
• using the first and second derivatives to find maxima, minima and inflection points to aid in graph sketching • determining vertical, horizontal and oblique asymptotes, and domains and ranges of a function • finding intervals where the derivative is greater than zero or less than zero in order to predict where the function is increasing or decreasing • verifying whether or not a critical point is a maximum or a minimum	AND, in one or more of the following, by: • constructing a mathematical model to represent a geometric problem, and using the model to find maxima and/or minima • constructing a mathematical model to represent a problem in economics, and using the model to find maximum profits or minimum cost
• using a given model, in equation or graph form, to find maxima or minima that solve a problem.	• constructing a mathematical model to represent a motion problem, and using the model to find maximum or minimum time or distance.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that complicated rates of change can be related to simpler rates, using the chain rule, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of related rates, by:
• relating the derivative of a complicated function to the derivative of simpler functions	• illustrating how the chain rule can be used to represent the relationship between two or more rates of change
• combining and modifying familiar solution procedures to form a new solution procedure to a related problem	• explaining the clarity that Leibnitz's notation gives to expressing related rates
• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem	• illustrating the time rate of change of a function $y=f(x)$ or a relation $R(x, y)=0$.
• constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change	
• expressing the connection between a derivative and the appropriate rate of change, and using this connection to relate complicated rates of change to simpler ones.	

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with related rates, by:	*Students will* demonstrate problem-solving skills, by:
• using the chain rule to find the derivative of a function with respect to an external variable, such as time • using Leibnitz's notation to illustrate related rates	• constructing a mathematical model to represent time rates of change of linear measures, areas, volumes, surface areas, etc. • solving related rate problems that use models containing primary trigonometric functions.
• constructing a chain rule of related rates, using appropriate variables • calculating related rates for the time derivatives of areas, volumes, surface areas and relative motion • calculating related rates of change with respect to time, given an equation that models electronic circuits or other engineering situations • using the chain rule to derive an acceleration function in terms of position, given a velocity function expressed in terms of position.	

INTEGRALS, INTEGRAL THEOREMS AND INTEGRAL APPLICATIONS (Required)

Overview

Corresponding to the operation of finding derivatives is the inverse operation of finding the antiderivatives. The area under a curve can be defined as the limit of the sum of small rectangular areas and can be found from this definition. The fundamental theorem of calculus links the solution of the area problem to the finding of special antiderivatives. As in the case of derivatives, the use of integral theorems makes the finding of antiderivatives and areas much easier. Derivatives and integrals can be interrelated through the context of nonuniform motion in a straight line.

Student Outcomes Summary

After completing this section, students will be expected to find the antiderivatives of any polynomial function, together with the antiderivatives of the simplest rational, algebraic and trigonometric functions. They will be expected to use antiderivatives to find areas under curves, and to use the connection between derivatives and integrals to relate displacement, velocity and acceleration. Conceptually, students will be expected to illustrate the properties of antiderivatives, definite integrals and the fundamental theorem of calculus, using geometric representations.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that the operation of finding a derivative has an inverse operation of finding an antiderivative, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of antiderivatives, by:
• giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals	• explaining how differentiation can have an inverse operation
• recognizing that integration can be thought of as an inverse operation to that of finding derivatives	• showing that many different functions can have the same derivative
• computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods	• representing, on the same grid, a family of curves that form a sequence of functions, all having the same derivative.
• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem.	

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with antiderivatives, by:	*Students will* demonstrate problem-solving skills, by:
• finding the antiderivatives of polynomials, rational algebraic functions and trigonometric functions	• finding the antiderivatives of rational functions and polynomial powers by comparison and inspection methods
• finding the family of curves whose first derivative has been given • solving separable first order differential equations for general and specific solutions.	• determining antiderivatives for polynomial, rational and trigonometric functions.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that the area under a curve can be expressed as the limit of a sum of smaller rectangles, and demonstrate this, by: • identifying and giving examples of the strengths and limitations of the use of technology in the computation of limits, derivatives and integrals • giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals • constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change.	*Students will* demonstrate conceptual understanding of area limits, by: • defining the area under a curve as a limit of the sums of the areas of rectangles • establishing the existence of upper and lower bounds for the area under a curve.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with area limits, by:	*Students will* demonstrate problem-solving skills, by:
• sketching the area under a curve (polynomials, rational, trigonometric) over a given interval, and approximating the area as the sum of individual rectangles.	• communicating the similarities and differences between definite integrals and areas under curves.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that the area under a curve can be related to the antiderivative of the function defining the curve; and in turn, can use the antiderivative to determine the areas under and between curves, and demonstrate this, by: • giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals • recognizing that integration can be thought of as an inverse operation to that of finding derivatives • describing the connections between the operation of integration with the finding of areas and averages • computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods • calculating the mean value of a function over an interval • constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change.	*Students will* demonstrate conceptual understanding of definite integrals, by: • identifying the indefinite integral $\int f(x)dx$ as a sum of an antiderivative $F(x)$ and a constant c • explaining how the definite integral between fixed limits a and b is a number whose value is $F(b) - F(a)$ • explaining the connection between the numerical values of the area and the definite integral for functions f of a constant sign and a variable sign • illustrating the following properties of $\int_a^b cf(x)dx = c\int_a^b f(x)dx$ $\int_a^b [f(x) \pm g(x)]dx = \int_a^b f(x)dx \pm \int_a^b g(x)dx$ • describing the sense of the fundamental theorem of calculus • explaining how the fundamental theorem of calculus relates the area limit to the antiderivative of a function describing a curve.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with definite integrals, by:	*Students will* demonstrate problem-solving skills, by:
• calculating the definite integral for polynomial, rational and trigonometric functions	• relating the value of the integral between $x=a$ and $x=b$ to the area between the curve and the x-axis over the interval $[a, b]$ • using integration theorems, such as those listed below, to simplify definite integrals $\int_a^b f(x)dx = -\int_b^a f(x)dx$ $\int_a^c f(x)dx = \int_a^b f(x)dx + \int_b^c f(x)dx$ • using integral theorems to simplify more complicated integrals • illustrating the conditions necessary for a function to be differentiable, or able to be integrated.

• determining the area between a curve and the x-axis over a given domain
• determining the area between a curve and the x-axis:
  • if $f(x)$ has a constant sign over a given interval
  • if $f(x)$ has a change in sign over a given interval	

• determining the area between curves over a given interval • determining the area between intersecting curves.	

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that velocity and acceleration are the first and second derivatives of displacement with respect to time; and that once one of the three functions is known, the other two can be found by finding derivatives or antiderivatives, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the relationships among displacement, velocity and acceleration, by:
• linking displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity	• describing the motion of a body, using sketches of the first and second derivatives
• calculating the displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity	• explaining the difference between a stationary point and a turning point in the context of linear motion
• calculating the mean value of a function over an interval	• illustrating the concepts of derivative and antiderivative in the context of displacement, velocity and acceleration.
• constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change.	

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with displacement, velocity and acceleration, by:	*Students will* demonstrate problem-solving skills, by:
• estimating an instantaneous velocity, using slopes of secant lines to represent average velocities	• solving problems associated with distance, velocity and acceleration whose models are restricted to those of the forms $y'(t)=f(t)$ and $y''(t)=f(t)$

• finding the first and second derivatives of a position function to get instantaneous velocity and instantaneous acceleration functions, where the position function is an algebraic function or a trigonometric function of time
• using antiderivatives of acceleration and velocity functions to get velocity and displacement functions.
	• deriving the following kinematic equations, starting from the expression $a=$constant:
	  • $v=at+v_0$
	  • $v^2=v_0{}^2+2ad$
	  • $d=\frac{1}{2}at^2+v_0\,t+d_0$
	• determining the equations of velocity and acceleration in simple harmonic motion, starting from the displacement equation:
	  • $x=A\cos(kt+c)$.

RELATED SPECIFIC LEARNER EXPECTATIONS FOR ELECTIVE COMPONENT

CALCULUS OF EXPONENTIAL AND LOGARITHMIC FUNCTIONS (Elective)

Overview

The calculus of exponential and logarithmic functions has many important applications in modelling natural phenomena, such as natural growth and decay, and problems involving return to equilibrium, such as those found in thermal and chemical reactions. The study of natural logarithms and the natural base exponential function is key in the development of derivatives and integrals for all such functions, as well as in their applications. This elective, together with the elective Applications of Calculus to Biological Sciences, can be taught as an integrated whole.

Student Outcomes Summary

After completing this elective section, students will be expected to represent symbolically and graphically, differentiate and integrate, exponential and logarithmic functions. They will also be expected to solve problems where the modelling equation is given, and to construct equations to model a situation with given parameters.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that exponential and logarithmic functions have limits, derivatives and integrals that obey the same theorems as do algebraic and trigonometric functions, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the calculus of exponential and logarithmic functions, by:
• computing limits of functions, using definitions, limit theorems and calculator/computer methods	• defining exponential and logarithmic functions as inverse functions • explaining the special properties of the number *e*, together with a definition of *e* as a limit
• computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods	• illustrating that the derivative of an exponential or logarithmic function may be derived from the definition of the derivative
• computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods	
• constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable	• illustrating that base-*e* exponential and logarithmic functions form a convenient framework within which the calculus of similar functions in any base may be developed
• fitting mathematical models to situations described by data sets.	• illustrating how exponential and logarithmic functions may be used to model certain natural problems involving growth, decay and return to equilibrium.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the calculus of exponential and logarithmic functions, by:	*Students will* demonstrate problem-solving skills, by:
• estimating the values of the limits e and e^x	• evaluating maxima and minima of given functions involving exponential and logarithmic functions • finding areas bounded by exponential, logarithmic or reciprocal functions
• approximating the slopes of $y=e^x$ and $y=\ln x$ for some specific value of x • finding the derivative and antiderivative of the base-e exponential function • using limit theorems to evaluate the limits of simple exponential and logarithmic functions • finding the derivative of the natural logarithmic function	AND, in one or more of the following, by: • relating natural growth, natural decay and return to equilibrium to the differential equations $y'=k\,y$ or $y'=k(y-y_0)$ • solving natural growth and decay problems, starting from the equations $y'=ky$ or $y'=k(y-y_0)$
• finding the derivatives of logarithmic functions having bases other than e • finding the derivatives and antiderivatives of exponential functions having bases other than e	• fitting exponential models to observed data • calculating distance, velocity and acceleration for falling bodies, with air resistance present as part of the model
• computing $\int_a^b \frac{1}{x}\,dx$ and $\int_a^b e^{kx}\,dx$ • solving the differential equations $y'=ky$ and $y'=k(y-y_0)$.	• connecting the integral $\int_a^b \frac{dx}{px+q}$ with the integral $\int_a^b \frac{dx}{x}$.

NUMERICAL METHODS (Elective)

Overview

Limits and derivatives are sometimes difficult to compute using algebraic methods, but often can be calculated more easily using numerical approximations and estimates. In the case of definite integrals, most functions cannot be integrated exactly, and numerical methods are necessary. This unit has a balance between intuitive methods based on guess-and-test, and formal procedures, such as Simpson's rule for definite integrals.

Student Outcomes Summary

After completing this elective section, students will be expected to compute numerical approximations for limits, equation roots and definite integrals. They will be expected to relate these procedures to the fundamental concepts of calculus studied in the required sections of Mathematics 31, and to apply these concepts to a variety of relations, functions and equations. Finally, they will be expected to evaluate the reliability of a numerical procedure and to communicate the results of the evaluation.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that many limits, derivatives, equation roots and definite integrals can be found numerically, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the principles of numerical analysis, by:
• identifying and giving examples of the strengths and limitations of the use of technology in the computation of limits, derivatives and integrals	• describing the difference between an exact solution and an approximate solution • identifying when a particular numerical method is likely to give poor results
• computing limits of functions, using definitions, limit theorems and calculator/computer methods	• explaining the difference between iterative and noniterative procedures
• computing derivatives of functions, using definitions, derivative theorems and calculator/computer methods	• explaining the basis of the Newton–Raphson procedure for determining the roots of $f(x)=0$
• computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods.	• describing the basis of a limit, derivative, equation root or integral procedure in geometric terms • connecting the number of subdivisions of the range of integration with the accuracy of the estimate for the integral • showing that all numerical integration formulas are procedures that interpolate between the lower and upper Riemann sums for the integral.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with numerical methods, by:	*Students will* demonstrate problem-solving skills, in one or more of the following, by:
• estimating the value of a limit by systematic trial and error • calculating the numerical value of the derivative at a point on a curve, whether or not there is a defining formula for the curve	• comparing the errors in computing definite integrals when using different procedures • writing computer software for the computation of limits, equation roots or definite integrals
• solving the equation $f(x)=0$ by systematic trial and error, and by the Newton–Raphson method	• reconstructing limit processes so that numerical evaluations can be efficient and reliable • evaluating the reliability of a numerical procedure for finding a limit, an equation root or a definite integral.
• calculating the upper and lower Riemann sums for a definite integral • calculating the value of a definite integral, using the midpoint rule • calculating the value of a definite integral, using the trapezoidal rule • calculating the value of a definite integral, using Simpson's rule.	

VOLUMES OF REVOLUTION (Elective)

Overview

Volumes of solids may be calculated using triple integrals, but for volumes formed by revolving the graphs of simple functions about the x- or y-axis, a single integration will suffice. By using limits to find an infinite sum of cylindrical volumes, a value for a volume of revolution can be found.

Student Outcomes Summary

After completing this elective section, students will be expected to find volumes of revolutions of the graphs of simple polynomial and trigonometric functions by using the "disc" method. Students will be expected to relate this procedure to that of finding the area between the graph of a function and the x-axis by the limit of the sum of a set of rectangles whose widths approach zero (a Riemann sum).

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that volumes of revolution may be considered as the limiting sum of smaller volumes and can be related to definite integrals, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of volumes of revolution, by:
• describing the connections between the operation of integration and the finding of areas and averages	• identifying the solid generated by the rotation of the graph of a function, either between two boundary values, or between two graphs
• combining and modifying familiar solution procedures to form a new solution procedure to a related problem	• explaining the connection between the volume of revolution and the volume of a cylindrical disc
• computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods	• demonstrating how the formula for the volume of revolution by the disc method could be generated.
• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem.	

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with volumes of revolution, by:	*Students will* demonstrate problem-solving skills, in one or both of the following, by:
• using the relationship $V=\pi\int_a^b [f(x)]^2dx$ to find the volume of revolution between the boundaries of a and b for polynomial and trigonometric functions • finding the volume of revolution between two polynomial or trigonometric functions by first finding the intersection points of the graphs of the two functions.	• deriving formulas for the volume of a cylinder, cone and sphere • revolving the graph of a function about a horizontal or vertical line, other than the x- or y-axis, and finding the resulting volume of revolution.

APPLICATIONS OF CALCULUS TO PHYSICAL SCIENCES AND ENGINEERING
(Elective)

Overview

Calculus is used extensively in physical sciences and in engineering. The study of energy, forces and motion can be represented in terms of differential equations that involve algebraic and trigonometric functions of time. These differential equation models, together with their solutions, can be used to make hypotheses and predictions.

Student Outcomes Summary

After completing this elective section, students will be expected to construct differential equation models for simple physical science and engineering situations, and to solve those models that involve algebraic and trigonometric functions of time.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that most of the important equations of physics are differential equations, and calculus provides the most efficient solution method, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the links among calculus, the physical sciences and engineering, by:
• linking displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity	• illustrating situations in which differential equations are required to represent problems
• describing the connections between the operation of integration with the finding of areas and averages • calculating the displacement, velocity and acceleration of an object moving in a straight line with nonuniform velocity	• developing one or more differential equations in the areas of linear motion, simple harmonic motion, work, hydrostatic force, moments of inertia, radioactive decay or similar situations
• calculating the mean value of a function over an interval • producing approximate answers to complex calculations by simplifying the models used • constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable • fitting mathematical models to situations described by data sets.	• showing that the concept of mean value can be applied to situations where the quantity varies with time, or where a range of values exists in a system of multiple bodies.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the application of calculus to the physical sciences and engineering, by:	*Students will* demonstrate problem-solving skills, in one of the following, by:
• solving differential equations of type $y''(t)=f(t)$	• determining the half-life, the decay rate, and the activity as a function of time for a radioisotope
• solving differential equations of type $y''(t)=-k^2y$	• analyzing the motion and energy in an oscillating spring system (Hooke's law)
• calculating the work done by any nonuniform force $f(x)$ using $W=\int_a^b f(x)dx$	• analyzing hydrostatic forces on the surface of submerged objects
• determining root-mean-square values for sinusoidal functions.	• determining the moment of inertia for rigid bodies
	• determining the centre of mass for individual bodies and for systems of bodies
	• integrating Newton's second law when expressed in the form $mx''(t)=f(x)$.

APPLICATIONS OF CALCULUS TO BIOLOGICAL SCIENCES (Elective)

Overview

Many biological problems are concerned with rates of growth, rates of decay, and rates of transport of energy and materials across boundaries. Mathematical solutions to many of these problems can be found by constructing differential equation models that have solutions involving exponential and logarithmic functions. This elective, together with the elective Calculus of Exponential and Logarithmic Functions, can be taught as an integrated whole.

Student Outcomes Summary

After completing this elective section, students will be expected to construct differential equation models for simple biological situations, and to solve those models that involve exponential and logarithmic functions.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that many important biological applications of calculus are connected with models involving the solution of the differential equation $f'(x) = kf(x)$, and demonstrate this, by: • combining and modifying familiar solution procedures to form a new solution procedure to a related problem • using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem • producing approximate answers to complex calculations by simplifying the models used • constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable • fitting mathematical models to situations described by data sets.	*Students will* demonstrate conceptual understanding of the links between calculus and the biological sciences, by: • defining exponential and logarithmic functions as inverse functions • explaining the special properties of the number e, together with a definition of e as a limit • illustrating that the derivative of an exponential or logarithmic function may be derived from the definition of the derivative • illustrating how differential equations may be used to model certain biological problems involving growth, decay and movement across a boundary.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the application of calculus to the biological sciences, by:	*Students will* demonstrate problem-solving skills, by:
• estimating the values of the limits e and e^x • using limit theorems to evaluate the limits of simple exponential and logarithmic functions • approximating the slopes of $y=e^x$ and $y=\ln x$ for some specific value of x • finding the derivative of the natural logarithmic function	• relating natural growth, natural decay and return to equilibrium to the differential equations $y'=ky$ or $y'=k(y-y_0)$ • solving natural growth and decay problems starting from the equations $y'=ky$ or $y'=k(y-y_0)$ AND, either, by: • fitting differential equation models to observed biological data
• finding the derivative and antiderivative of the base-e exponential function • using methods of guess-and-test, and comparing coefficients to solve the differential equations $y'=ky$ and $y'=k(y-y_0)$ • verifying that $y=Ae^{kx}$ satisfies the differential equation $y'=ky$.	OR, both of the following, by: • relating growth subject to limits to the logistic equation $y'=ky(L-y)$ • solving logistic equation models, and estimating values for the parameters k and L, from experimental data.

APPLICATIONS OF CALCULUS TO BUSINESS AND ECONOMICS (Elective)

Overview

Although there are far too many variables and influences present to make a complete analysis of economic situations, many of them can be simplified to a point where Mathematics 31 students can begin to understand the applications of calculus to this area of study.

Student Outcomes Summary

After completing this elective section, students will be expected to analyze an economic model based on the need to maximize revenue and profit while minimizing cost.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that calculus may be used as a tool to analyze situations in business and economics that involve revenue, profit and cost, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the links among calculus, business and economics, by:
• relating the zeros of the derivative function to the critical points on the original curve	• explaining how calculus procedures frequently arise in models used in business and economics
• producing approximate answers to complex calculations by simplifying the models used	• explaining how both maximum and minimum values are important in the making of business and economic decisions.
• constructing mathematical models for situations in a broad range of contexts, using algebraic and trigonometric functions of a single real variable	
• determining the optimum values of a variable in various contexts, using the concepts of maximum and minimum values of a function	
• using the concept of critical values to sketch the graphs of functions, and comparing these sketches to computer-generated plots of the same functions	
• fitting mathematical models to situations described by data sets.	

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the application of calculus to business and economics, by:	*Students will* demonstrate problem-solving skills, in one or both of the following, by:
• sketching polynomial, exponential and trigonometric functions of one variable	• determining a revenue, profit or cost function from a problem situation that can be modelled, using polynomial functions
• using a given revenue, profit or cost function to calculate and justify optimum values • finding the maximum of a revenue or profit function that is expressed as a function of price or number sold • finding the minimum of a cost function that is expressed as a function of price or number sold.	• modelling the business cycle, using trigonometric functions.

CALCULUS THEOREMS (Elective)

Overview

The simple geometric representations of limit, continuity, derivative and integral work well for most functions used in problem applications. However, it is possible to give examples of misleading conclusions when these representations are being used. This elective section shows these examples and leads the student into a deeper knowledge, and the proofs, of the basic limit, derivative and integral theorems.

Student Outcomes Summary

After completing this elective section, students will be expected to illustrate the differences between intuitive proofs and rigorous proofs in the context of proof, construct a counterexample to a hypothesis, and construct a rigorous proof of one of the simpler limit, derivative or integral theorems.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that limit, derivative and integral theorems can be proved at different levels of rigor, from intuitive to analytic, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the nature of proof in the context of limit, derivative and integral theorems, by:
• giving examples of the differences between intuitive and rigorous proofs in the context of limits, derivatives and integrals	• proving the equivalence of the product and the quotient rule for derivatives
• calculating the mean value of a function over an interval	• comparing the nature of intuitive and rigorous proofs knowing the conditions under which a theorem is true
• constructing geometrical proofs at an intuitive level that generalize the concepts of slope, area, average and rate of change.	• explaining what is an example, and what is a counterexample
	• illustrating the intermediate value theorem, Rolle's theorem, the mean value theorem and the fundamental theorem of calculus, by examples and counterexamples, using both graphical and algebraic formulations.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with the construction of proofs of limit, derivative and integral theorems, by:	*Students will* demonstrate problem-solving skills, by:
• using specific functions to illustrate the equivalence of the product and quotient rules	• composing rigorous proofs for derivative theorems, starting from the corresponding limit theorems
• locating an error in a given proof of a calculus theorem	AND, in one of the following, by:
	• deriving formulas for the derivatives of complicated functions, using the basic rules; e.g., functions, such as $y=\frac{f(x)g(x)}{h(x)}$ or $y=f(g(h(x)))$
• verifying the mean value theorem and the fundamental theorem of calculus for specific examples.	• proving that a differentiable function satisfies the mean value theorem
	• constructing, and justifying, an iterative solution procedure for the equation $f(x)=c$, using the intermediate value theorem.

FURTHER METHODS OF INTEGRATION
(Elective)

Overview

Certain algebraic and trigonometric functions cannot be integrated using the usual methods involving the power rule. It is therefore necessary to look at other methods; these being integration by substitution, integration by parts, or integration by partial fractions.

Student Outcomes Summary

After completing this elective section, students will be expected to recognize which particular method of integration is needed. They will also be expected to use and combine these methods appropriately in evaluating with indefinite and definite integrals.

GENERAL LEARNER EXPECTATIONS	CONCEPTUAL UNDERSTANDING
Students are expected to understand that integration by substitution, by parts, and by partial fractions are procedures necessary when dealing with certain algebraic and trigonometric functions, and demonstrate this, by:	*Students will* demonstrate conceptual understanding of the methods of integration, by:
• recognizing that integration can be thought of as an inverse operation to that of finding derivatives	• identifying integrals that cannot be evaluated, using the antiderivatives of polynomial or trigonometric functions
• expressing final algebraic and trigonometric answers in a variety of equivalent forms, with the form chosen to be the most suitable form for the task at hand	• showing how substitutions into a definite integral change both the function to be integrated and the limits of integration
• computing definite and indefinite integrals of simple functions, using antiderivatives, integral theorems and calculator/computer methods	
• using the connections between a given problem and either a simpler or equivalent problem, or a previously solved problem, to solve the given problem.	• recognizing when it would be appropriate to use integration by substitution, by parts or by partial fractions.

PROCEDURAL KNOWLEDGE	PROBLEM-SOLVING CONTEXTS
Students will demonstrate competence in the procedures associated with methods of integration, by:	*Students will* demonstrate problem-solving skills, by:
	• deriving the formula for integration by parts, using the formula for the derivative of a product
• using a change of variable to integrate by substitution	• combining two or more methods to integrate a rational algebraic function
• using a trigonometric substitution to integrate algebraic functions containing terms, such as $\sqrt{a^2-x^2}$	• adapting integration methods for antiderivatives to the evaluation of definite integrals.
• using a trigonometric identity as a first step in an integration by substitution	
• using integration by parts to integrate a product	
• writing a rational function as a sum of partial fractions	
• using integration by partial fractions to integrate rational algebraic functions.	

C. BASIC LEARNING RESOURCES

Nonprint

Catch 31. Edmonton, AB: ACCESS Network. 1991. [video]

Program 1: History, Background and Limits
2: The Derivative of First Principles: The Power Rule
3: The Sum Rule: The Chain Rule
4: Product and Quotient Rules
5: Problems and Graph Sketching
6: Maxima and Minima
7: Distance, Velocity and Acceleration
8: Derivatives for Relations
9: Related Rates
10: Integration
11: Areas Under or Between Curves

Pitre, Michel. *Zap-A-Graph.* Macintosh version 4.0, or higher. Fitzroy Harbour, ON: Edupro Software Ltd., 1993. [software]

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Reid, Neal, Douglas Mark, Phil Feldman, Russell Garrett, Joseph Geiser and David Handley. *Calculus: A Problem-Solving Approach.* Toronto, ON: John Wiley & Sons Canada Limited, 1988.

ISBN 0471796905

Stewart, James, Thomas M. K. Davison and Bryan Ferroni. *Calculus: A First Course.* Toronto, ON: McGraw-Hill Ryerson Limited, 1989.

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D. BASIC LEARNING RESOURCES

Mathematics 13

Baxter, W. H. *Mathematics for a Modern World, Book 2.* Third edition, revised. Agincourt, ON: Gage Educational Publishing Company, 1989.

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Ebos, Frank and Paul Zolis. *Math Matters, Book 2.* Alberta edition. Scarborough, ON: Nelson Canada, 1989.

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Landwehr and Watkins. *Exploring Data.* Palo Alto, CA: Dale Seymour Publications, 1986.

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Mathematics 23

Carli, E. G., K. E. Newton and J. S. Telfer. *Mathematics for a Modern World, Book 3.* Third edition. Toronto, ON: Gage Educational Publishing Company, 1985.

ISBN 0771536232

Dottori, Dino, George Knill, John Seymour, Ann Jones, Robert Alderson and Darrell McPhail. *Applied Mathematics 11.* Second edition. Toronto, ON: McGraw-Hill Ryerson Limited, 1988.

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Ebos, Frank, Paul Zolis and Barbara Morrison. *Math Matters, Book 3.* Alberta edition. Scarborough, ON: Nelson Canada, 1991.

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Newman, Claire M., Thomas E. Obremski and Richard L. Scheaffer. *Exploring Probability.* Palo Alto, CA: Dale Seymour Publications, 1987.

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Mathematics 33

Carli, Newton, Telfer. *Mathematics for a Modern World, Book 4.* Alberta edition. Toronto, ON: Gage Educational Publishing Company, 1988.

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Ebos, Morrison. *Math Matters, Book 4.* Alberta edition. Scarborough, ON: Nelson Canada, 1991.

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Mathematics 13–23–33

Pitre, Michel. *Zap-A-Graph.* Macintosh version 4.0, or higher. Fitzroy Harbour, ON: Edupro Software Ltd., 1993. [software]

_____. *Zap-A-Graph FPU.* Macintosh version 4.0, or higher. Fitzroy Harbour, ON: Edupro Software Ltd., 1993. [software]

NATIVE LANGUAGES

CONTENTS

★ Blackfoot Language and Culture 10–20–30

★ Cree Language and Culture 10–20–30

★ For current information on basic learning resources, consult the Learning Resources Distributing Centre *Buyers Guide*.

OTHER COURSES

CONTENTS

Special Projects 10–20–30

Work Experience 15–25–35

SPECIAL PROJECTS 10–20–30

Special projects credits are designed to recognize work undertaken by students on an individual or small group basis and should not be used as a means of offering credits for unapproved courses. Students may enroll in Special Projects 10, 20 or 30. Special Projects 20 and Special Projects 30 do not have prerequisites.

PURPOSE

Special projects credits perform two major functions:

- Students become involved in the selection, planning and organization of their own programs.
- Students pursue activities in which they have considerable interest or ability but which are not within the scope of the regular curriculum or the programs being offered in the school.

PROCEDURES

Requirements for special projects credits are:

- Each project shall be carried out under the supervision of a teacher.
- Students are required to submit a clearly planned proposal to the principal for approval. The proposal should include:
  - a description or outline of the project
  - the number of hours of work expected to complete the project
  - a method by which the project will be carried out
  - a description of the expected result
  - the evaluation procedures as outlined by a teacher
  - an expected completion date
  - the name of the supervising teacher.
- The principal shall retain a copy of each special project proposal until the project is completed.
- The opportunity to earn special projects credits shall be available to all students, including those attending an authorized summer school.
- The content of the special project need not be related to a specific school subject.
- If a special project is related to a specific school subject, the content of the project shall be distinct from and in addition to regular course requirements.
- Projects shall be completed and reported to the principal prior to the conclusion of the semester or full term.
- Where a project takes a student off campus, the provisions of the *Off-campus Education* policy (see *Alberta Education Policy, Regulations and Forms Manual*) shall apply.
- Special projects credits may be applied toward the Alberta High School Diploma and, until 1997, toward the Advanced High School Diploma (as unspecified credits only), and to the General High School Diploma (as either specified or unspecified credits).
- Students who successfully complete projects are granted 3 credits for 75 hours of work or 5 credits for 125 hours of work in any one semester, or full term on the approval of the principal.

- School jurisdictions shall develop policies to ensure overall consistency and standardization of procedures governing special projects in their schools. Evaluation and reporting procedures should be included in the policy.

Restrictions on special projects are:

- Special projects credits shall not be awarded for student activities that would be considered a normal part of extracurricular or cocurricular activities generally offered by a school; e.g., school team sports, school newspaper, yearbook.
- In instances where a student enrolls in more than one special project, credits shall not be approved unless the projects vary substantially from year to year or demonstrate increased levels of proficiency.

WORK EXPERIENCE 15–25–35

Work Experience 15–25–35 are separate courses for credit that provide experiential learning activities undertaken by a student as an integral part of a planned school program under the cooperative supervision of a teacher–coordinator and employer.

Work Experience 15–25–35 courses are components of an off-campus education program. These courses, like other off-campus education courses and course components, provide opportunities for students to:

- apply, in the workplace, knowledge, skills and attitudes acquired through other course work
- discover their career interests and aptitudes in meaningful work activities, situated in community-based work stations and work sites in business, industry, government and community service.

Work experience courses also provide opportunities for the school and its community to combine resources to further the student's personal development, career planning and employability skills through placements in off-campus work stations or work sites.

Off-campus education programs are a major thrust within Alberta Education's *Meeting the Challenge: Three-Year Business Plan.* The document states that:

> Senior high school students will be able to learn employability skills in the workplace. The school will provide support to ensure a broad theoretical understanding for those specific skills. The province will provide high school credit for workplace learning that is certified by the school and by the employer. This will ensure students have the skills demanded by business and gain recognized work experience to assist in making the transition from school to work.

Work Experience 15–25–35 courses, at each level, may be offered for 3, 4, 5, 6, 7, 8, 9 or 10 credits. Each course is time based; i.e., 25 hours per credit, and a student may enroll in Work Experience 35 without having completed Work Experience 15 and/or Work Experience 25.

For students who entered Grade 10, as of September 1994, the number of work experience credits that may be counted toward the Alberta High School Diploma is fifteen.

There are no basic learning resources for Work Experience 15–25–35 courses. However, related support resources are available for the Career Readiness modules in the Career Transitions strand of the Career and Technology Studies program. These resources are listed in the *Career Transitions Guide to Standards and Implementation*, Interim 1995.

Career Readiness modules are linked to Work Experience 15–25–35 courses as follows:

- Module CT101: Job Preparation, will be a <u>required</u> component of the first work experience course taken by a student.

- Module CT201: Job Maintenance, will be a recommended component of the second work experience course taken by a student.

- Module CT301: Preparing for Change, will be a recommended component of the third work experience course taken by a student.

Specific procedures and legislation about off-campus education and work experience courses are provided in the *Off-campus Education Guide for Administrators, Counsellors and Teachers*, 1995, and the *Alberta Education Policy, Regulations and Forms Manual*.

PERSONAL DEVELOPMENT

CONTENTS

Health and Personal Development 10

Career and Life Management 20

Occupations 10

Physical Education 10–20–30

Driver and Traffic Safety Education 10

4. a sensitivity toward and appreciation of the beauty of skilled movement

5. an appreciation of their own growth and development in social, emotional, ethical and physical areas.

Goal 5

The physical education program will assist the student to develop positive interpersonal skills transferable to other areas of their lives.

Learner Outcomes

Students will develop:

1. appreciation of the worth of others and respect for their rights

2. consideration and understanding of the needs, strengths and limitations of others

3. attitudes and skills of cooperation and conciliation essential to fair play, competition and team interaction, as well as to leadership and the ability to follow a leader

4. appreciation of and ability to act in accord with game etiquette and the values of loyalty, honesty, dependability, kindness and generosity.

CONTENT

Secondary Physical Education Program Model

The secondary physical education program is comprised of seven dimensions: aquatics, dance, fitness, games, gymnastics, individual activities and outdoor pursuits. By engaging in a balanced selection of activities drawn from each dimension at levels appropriate to each student's unique ability and aptitude, students will develop their physical skills, knowledge of physical movement, positive personal attributes and interpersonal skills and attitudes. Confidence, respect for oneself and others, and a predisposition toward lifelong engagement in physical activity, with the attendant rewards of health, self-esteem and positive social relationships, are the long-term objectives of the physical education program.

Program Balance

A well-balanced program provides opportunities for students to participate in activities from all seven dimensions, appreciating local or individual considerations such as access to facilities, religious persuasion or health. A balanced physical education program drawn from each of the seven dimensions will provide a broad and varied program of physical education.

Activity selection and time allocation will be determined by the needs and development of the students, by the program objectives and by many other factors.

The balance may also differ from grade to grade depending on such factors as individual needs, time and facilities.

APPLICATION OF THE SECONDARY PHYSICAL EDUCATION PROGRAM

The senior high physical education program is an extension of the Grade 7 through Grade 9 program and is intended to provide students in Grade 10 through Grade 12 with an opportunity to further their development of skills in a variety of physical activities at levels of proficiency reflective of each student's unique abilities. It is therefore mandatory that all seven dimensions of the program be addressed in the required component of each course in Grade 10, notwithstanding the exemptions specified below.

Because of the greater proficiency of skills of most students who pursue the complementary 20 and 30 courses, the study of all seven dimensions is not required at the complementary level. However, the fitness dimension must be included in both Physical Education 20 and 30. The complementary physical education program should accommodate a variety of student needs, interests and abilities, and should aim at a balance of many dimensions rather than over-emphasis on one aspect of the program.

The core and complementary program models are presented on page 6.

Required/Elective Components

Each dimension of the Grade 10 physical education program must receive no less than 10% of the available instructional time at each grade level. The required component of 80% of the available instructional time therefore allows the remaining 10% to be used for extension of one or more dimensions. The 20% elective component can be applied to one or more of the dimensions for enrichment or remediation. This 20% is not an addendum to the required component but should be used throughout the duration of the course as indicated by student needs and interests.

At the Grade 11 and Grade 12 level, 70% of the total instructional time should be devoted to the required component of the program, and 30% to the elective. The elective may be used to extend the required component, to address dimensions not incorporated into the required component, or to provide special emphases.

Exemptions

As an integral part of the well-balanced physical education program, activities should be selected to contribute to the attainment of the learner expectations. In the following specified circumstances, however, exemptions may be warranted from one or more dimensions of the course.

PROGRAM EXEMPTIONS

Category	Conditions for Exemption	Procedures	Alternative Experiences
INDIVIDUAL	Religious beliefs	• Statement in writing from parent to principal.	• When exemption is granted, alternative activities consistent with the goals and objectives of the specific dimension should be substituted, where appropriate.
INDIVIDUAL	Medical	• Certification to principal by medical practitioner with statement of activities in which the student is not able to participate.	
CLASS, GRADE OR SCHOOL	Access to facilities	• Initiated by local school authority or parent. • Approved by local school authority.	

Variable Credit Programming

Physical education at the senior high school level permits variable credit programming and requires a demonstrated progression of learning between each of the senior high grades. Because the program accommodates a wide variation of student ability levels, students from all program routes should be able to participate successfully in Physical Education 10.

The choice to offer Physical Education 10, 20 or 30 for 3, 4 or 5 credits is accommodated by placing the required minimum percentage of time per dimension (e.g., 10%) against a 75-, 100- or 125-hour time frame. The emphasis on each dimension within the required component remains constant while the time and credit values vary.

Complementary Secondary Physical Education Program

Physical Education 20–30 are complementary courses (i.e., optional) but may be used to fulfill additional credit requirements for the Advanced or General High School Diplomas. The prerequisite nature of the Physical Education 10–20–30 sequence requires increased complexity of physical, cognitive or affective demands and differentiated content at each successive grade level. Credits are awarded on the basis that the experience provided at each grade is differentiated from the previous grade and that performance expectations increase hierarchically. A logical and articulated transition in scope and sequence of content is also required. Dimensions included for additional study should contain some activities never before covered. Activities that were studied from Grade 7 through Grade 10 should be covered at a more sophisticated level.

Physical Education 20 will build upon the skills of students entering from Physical Education 10, but will provide opportunity for further expansion and depth of learning. Physical Education 30 will be an extension, but not a duplication of the Physical Education 20 program. The articulated 10–20–30 program should culminate in Physical Education 30.

The program models for the core physical education program (Grade 10), and the complementary physical education program (Grade 11 and Grade 12), are presented below.

CORE PHYSICAL EDUCATION PROGRAM

Physical Education 10	
Required★ 80%	Elective 20%
1. Aquatics 2. Dance 3. Fitness 4. Games A and B 5. Gymnastics 6. Individual activities 7. Outdoor pursuits	The 20% elective time can be used for remediation or enrichment of the required program content.

★No less than 10% of the instructional time must be allocated to each dimension in the required component of the Grade 10 program. This allows 10% flexibility for extension of one or more dimensions in the required component of the program.

COMPLEMENTARY PHYSICAL EDUCATION PROGRAM

Physical Education 20	
Required 70%	Elective 30%
1. Fitness 2. A minimum of three other dimensions • aquatics • dance • games • gymnastics • individual activities • outdoor pursuits	1. The 30% elective time can be applied to an extension of the required component. 2. The 30% elective time can be applied to one or more of the remaining dimensions not used to make up the 70% required component. 3. Instruction may include special emphasis on such areas as: contemporary issues, officiating, leadership, history, sports medicine, anatomy, kinesiology, etc.

Physical Education 30	
Required 70%	Elective 30%
1. Fitness 2. A minimum of two other dimensions • aquatics • dance • games • gymnastics • individual activities • outdoor pursuits	1. The 30% elective time can be applied to an extension of the required component. 2. The 30% elective time can be applied to one or more of the remaining dimensions not used to make up the 70% required component. 3. Instruction may include special emphasis on such areas as: contemporary issues, officiating, leadership, history, sports medicine, anatomy, kinesiology, etc.

SCIENCE

CONTENTS

Science
(Vision Statement, 1994)

Science 10

★ Biology 20–30

★ Chemistry 20–30

★ Physics 20–30

★ Science 20–30

Science 14–24

★ The new senior high 20-level science courses were provincially implemented in September of 1993. The new 30-level science courses were provincially implemented in September of 1994. Copies of the interim programs of study, dated June 30, 1995, for Biology 20–30, Chemistry 20–30, Physics 20–30 and Science 20–30 are available for purchase from the Learning Resources Distributing Centre.

BIOLOGY 20–30

The new senior high school Biology 20–30 program has been provincially implemented. The program of studies was sent to schools and school systems in June of 1994. Since then, minor changes have been made to the program, but no further mailout is planned. However, the interim program of studies, dated June 30, 1995, is available for purchase from the Learning Resources Distributing Centre.

CHEMISTRY 20–30

The new senior high school Chemistry 20–30 program has been provincially implemented. The program of studies was sent to schools and school systems in June of 1994. Since then, minor changes have been made to the program, but no further mailout is planned. However, the interim program of studies, dated June 30, 1995, is available for purchase from the Learning Resources Distributing Centre.

PHYSICS 20–30

The new senior high school Physics 20–30 program has been provincially implemented. The program of studies was sent to schools and school systems in June of 1994. Since then, minor changes have been made to the program, but no further mailout is planned. However, the interim program of studies, dated June 30, 1995, is available for purchase from the Learning Resources Distributing Centre.

SCIENCE 20–30

The new senior high school Science 20–30 program has been provincially implemented. The program of studies was sent to schools and school systems in June of 1994. Since then, minor changes have been made to the program, but no further mailout is planned. However, the interim program of studies, dated June 30, 1995, is available for purchase from the Learning Resources Distributing Centre.

SECOND LANGUAGES

CONTENTS

French as a Second Language (ECS to Grade 12)

★ German
10–20–30

★ Italian
10–20–30

★ Latin
10–20–30

★ Spanish
10–20–30

★ Ukrainian
Three-year Program — Ukrainian 10–20–30
Six year Program — Ukrainian 10S–20S–30S

★ For current information on basic learning resources, consult the Learning Resources Distributing Centre *Buyers Guide*.

D. BASIC LEARNING RESOURCES

French 13
[Beginning level 1, 2]

Miller, Ann and Liz Roselman. *Arc-en-ciel 1.* London, England: Mary Glasgow Publications, 1988.

ISBN 1852341742

French 10
[Beginning level 2, 3]

Jean, Gladys. *Entre amis 1.* Scarborough, ON: Prentice-Hall Canada Inc., 1990.

ISBN 0132825422

McConnell, G. Robert, Rosemarie Giroux Collins and Jocelyn M. Mennill. *Savoir faire: Passages 1.* Don Mills, ON: Les Éditions Addison-Wesley Limitée, 1993.

ISBN 0201574209

Miller, Ann, Liz Roselman and Marie-Thérèse Bougard. *Arc-en-ciel 2.* London, England: Mary Glasgow Publications, 1989.

ISBN 1852342331

Mills, Barbara and Elver Peruzzo. *Entrez 1.* Scarborough, ON: Copp Clark Pitman Ltd., 1987.

ISBN 0773045635

French 20
[Intermediate level 4, 5]

Brown, Diane G., Janet Flewelling and Lise-Anne Laverdure. *Destinations 2.* Mississauga, ON: Copp Clark Pitman Ltd., 1991.

ISBN 077304955X

Duplantie, Monique, Clément Beaudoin and Jocelyne Hullen. *Élans 1: Première partie.* Montréal, PQ: Centre Éducatif et Culturel inc., 1990.

ISBN 2761707729

_____. *Élans 1: Deuxième partie.* Montréal, PQ: Centre Éducatif et Culturel inc., 1991.

ISBN 2761709705

Gollert, Heidi, Elver Peruzzo and Claire Piché. *Destinations 3.* Mississauga, ON: Copp Clark Pitman Ltd., 1992.

ISBN 0773051341

Jean, Gladys, Barbara Moscovich and Bruce Hartley. *Entre amis 2.* Scarborough, ON: Prentice-Hall Canada Inc., 1992.

ISBN 0132852896

Jean, Gladys et al. *Entre amis 3.* Scarborough, ON: Prentice-Hall Canada Inc., 1992.

ISBN 0132879883

Jean, Gladys. *Le magazine entre amis 3.* Scarborough, ON: Prentice-Hall Canada Inc., 1993.

ISBN 0130358584

McConnell, G. Robert, Rosemarie Giroux Collins and Jocelyn M. Mennill. *Savoir faire: Passages 2.* Don Mills, ON: Les Éditions Addison-Wesley Limitée, 1993.

ISBN 0201552000

McConnell, G. Robert. *Savoir faire: Passages 3.* Don Mills, ON: Les Éditions Addison-Wesley Limitée, 1991.

ISBN 0201573776

Miller, Ann, Liz Roselman and Marie-Thérèse Bougard. *Arc-en-ciel 3*. London, England: Mary Glasgow Publications, 1990.

ISBN 1852342773

Peruzzo, Elver and Barbara Miles. *Entrez 2*. Mississauga, ON: Copp Clark Pitman Ltd., 1989.

ISBN 0773048596

Ullmann, Rebecca, Bonnie Carter and Sylvia I. Goodman. *Tous ensemble!: Réflexions*. Toronto, ON: D. C. Heath Canada Limited, 1992.

ISBN 0669953687

French 30
[Intermediate level 5, 6]

Bougard, Marie-Thérèse et al. *Arc-en-ciel 4*. London England: Mary Glasgow Publications, 1991.

ISBN 1852343613

Duplantie, Monique, Jocelyne Hullen and Roger Tremblay. *Élans 2: Première partie*. Montréal, PQ: Centre Éducatif et Culturel inc., 1992.

ISBN 2761710126

Gollert, Heidi, Elver Peruzzo and Claire Piché. *Destinations 3*. Mississauga, ON: Copp Clark Pitman Ltd., 1992.

ISBN 0773051341

Jean, Gladys et al. *Entre amis 3*. Scarborough, ON: Prentice-Hall Canada Inc., 1992.

ISBN 0132879883

_____. *En direct 1*. Scarborough, ON: Prentice-Hall Canada Inc., 1993.

ISBN 0130622095

McConnell, G. Robert. *Savoir faire: Passages 3*. Don Mills, ON: Les Éditions Addison-Wesley Limitée, 1991.

ISBN 0201573776

Peruzzo, Elver, Claire Piché and Heidi Gollert. *Destinations 4*. Mississauga, ON: Copp Clark Pitman Ltd., 1993.

ISBN 0773052011

Ullmann, R. et al. *Reflexions 2: Student Magazine*. Toronto, ON: D. C. Heath Canada Ltd., 1993.

ISBN 0669954128

Ullmann, Rebecca et al. *Tous ensemble!: Altitude*. Toronto, ON: D. C. Heath Canada Ltd., 1993.

ISBN 0669953733

French 31a, 31b, 31c
[Advanced level 7, 8, 9]

Bérard, E. and C. Lavenne. *Exercises pour l'apprentissage du Français*. Paris, France: Les Éditions Didier, 1992.

ISBN 2278038400

_____. *Grammaire Utile du Français*. Paris, France: Hatier, 1989.

ISBN 2218015943

Boucher, Anne-Marie et al. *Via: manuel de l'élève*. Ville LaSalle, PQ: Éditions Marcel Didier inc., 1992.

ISBN 2891442369

_____. *Via: cahier d'activités*. Ville La Salle, PQ: Éditions Marcel Didier inc, 1992.

ISBN 2891442377

Daumont-Spragg, C. and R. Cottrell. *Colloques: Textes du Monde francophone*. Montréal, PQ: Centre Éducatif et Culturel inc., 1987.

ISBN 2761704002